SUPPLEMENT.

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FORMING A COMPLETE RECORD OF THE PROCEEDINGS OF ALL PUBLIC COMPANIES.

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The Royal School of Mines, Jermyn Street.

Mr. WARINGTON SMYTH'S LECTURES.

[FROM NOTES BY OUR OWN REPORTER.]

Lecture XLVII.—There are one or two dangers (continued Mr. Smyth) in traversing the shafts which I have not yet mentioned, but which cannot be passed over. One of these is overwinding, and it is really remarkable that so many lives should be lost every year from a cause so completely under the control of the persons employed in the work. This is done by the carelessness and inadvertance of the engineman, and the results are often of a most distressing character. If, when the cages with their load of workmen come to the surface the engine still goes on, they are brought up with great force against the pulleys, the rope is broken, and the poor fellows are precipitated to the bottom of the pit beneath. With the large drums now in use the cage is often raised 60 or 70 feet at each stroke of the engine, and thus one stroke too many will be enough to produce fatal results. The chief guard against such accidents are self-acting signals within the engine-house to tell the engineer to lower his speed; and brakes of more or less efficiency, and of late steam brakes, have been used, which are often self-acting, and come into play as soon as the cage passes a certain point in the guides. Another danger arises from the accidental fall of materials down the shafts on to the heads of the men in the cages, and a cover or bonnet of sheet iron is now very generally added to the cage as a protection. I have already described the Fahrkunst, or man-engine, which is by far the safest and most economical mode of transporting the miners up and down the shafts, but, although long tried and highly praised in our Cornish mines, has not yet been generally adopted in the colliery districts. There the men have a strong prejudice in favour of the rope and the cage, by which, although one party of men passes through the shafts more rapidly, the transit of the whole complement occupies the engine much longer. Nevertheless an entire pit's crew of 400 or 500 men may be conveyed in little more than an hour.

A very important work to which shafts are devoted is that of pumping out the water which, from various causes, may accumulate in the mine. We have already seen, in considering the work of "tubbing," that water met with in the shaft may be so effectually excluded as to admit of a mine being worked dry beneath heavy feeders, but such cases are rare, and either because the circumstances are unfavourable to such a work, or from its not being attempted, an expensive system of pumping has to be maintained.

We now come, therefore, to the modes of raising water from mines, and this is frequently done, especially for temporary purposes, by the engine erected for winding the mineral. The subject of drainage of mines should be looked at from a general point of view, as water occurs in mines under the most varied circumstances. It often happens that a great deal of the water can be got rid of without being constantly pumped out. It is frequently the case in dealing with collieries that a band or bed of very porous material is passed through in sinking the shaft quite near the surface. We have already seen how the water in such an instance may be tubbed out, and if we meet with other feeders they generally can be treated in the same way, and that in the case of several watery beds coming together the different lengths of tubbing may be joined. When, however, the seam of coal or other mineral we are going to work is very near to one of these feeders, it is evident that we must arrange our workings in such a way as not to run the risk of letting the water we have already tubbed out break into the workings, as the consequences of such a catastrophe would be very serious. In places where these precautionary measures are successfully taken it often occurs that the workings are carried on over a considerable area without any irruption of the water whatever, and, therefore, the pumping apparatus is altogether dispensed with. The difficulty of dealing with the water is much greater in metalliferous mines than in stratified deposits, and it must depend upon local circumstances whether it will be better to dam the water back or to pump it to the surface. It is noticeable that there is a large accession of water in deep workings on the lapse of a certain interval after the rainy season. For instance, in the mines of Cornwall it is found necessary in the spring to work the pumping-engines faster by an additional stroke per minute than at any other period of the year. It is, therefore, an important point to drain the mine as much as possible by means of adit levels, and also to intercept the water at as low a depth as possible, so as to diminish the expense of pumping it out. In many instances it is impossible to keep out the water by means of tubbing in metalliferous mines, as the veins extend over a great extent of ground, and if we tubbed at one place the water will find its way in at another. [The lecturer here illustrated this point by numerous drawings.] To keep water back by dams we must select a narrow part of the level, where the ground is of a very strong character, and then we cut a niche in each side of the level, and put in timbers from side to side, which must be made water-tight by filling in the interstices with packing, &c. The dam must be planned out according to the height of the column of water or the pressure to be withstood, and if there is a constant flow of water in the level it will be necessary to put in a pipe to carry off the water during the erection of the dam. It is also extremely important to take care that all the air is extracted from the back of the dam prior to closing it up, otherwise its stability will be very much impaired. The ground selected for a dam ought to be very strong and impervious both above and below, so that the water shall not infiltrate through it, and so get at the portion of the level which it is desired to keep free from water. The most satisfactory form of dam ever devised is the "frame dam," which is very common in Saxony, but which has only of late found favour in England, except in the North, but which is capable of withstanding an enormous amount of pressure. It is conical in form, like a stopper. In some of the Belgian mines dams are often constructed of masonry or brickwork, but the same conditions are requisite. The cost of damming is very considerable, in consequence of the great amount of careful work they involve. Many thousands of wedges have to be put in, and there is great difficulty very often of making the stopping water-tight. If the work be inferior or faulty in any part the dam will sooner or later give way, and, perhaps, occasion the loss of many lives. There are cases in which everything that experience and skill can devise has been done, and yet the dam has failed, and it is, therefore, always a period of great anxiety when the openings are closed, and the dam is left to do its work. It is carefully watched to see whether it will stand the test, and it is extremely unpleasant under such circumstances to detect the water trickling through. Having in this way, and by other means, kept out all the water that is possible to exclude, arrangements must be made for removing the residue; and the next phase of the subject will, therefore, be that in which pumping machinery comes into play.

Lecture XLVIII.—The subject (said Mr. Smyth) of the modes of pumping out water from mines is one of such very great importance that it would not be too much to say that an entire course of lectures could be very advantageously devoted to it. I dwelt, especially yesterday, on the methods of constructing dams for the purpose of damming out water in levels; but in a similar manner, though far less frequently, it is requisite at times to construct dams in shafts for divers purposes. I mentioned on a former occasion a case which has attracted some attention in the mining world, of a colliery district where the water rose in a shaft from certain bands of porous strata up to a portion of the ground where a valuable colliery was in operation. Now this, in fact, is more or less the condition under which what is known as Artesian wells are often put down to very great depths for the supply of cities and towns with water. But there may be circumstances occasionally occurring in mines under which it may be desirable at some time or other to close up the shaft by means of a water-tight dam. The mere throwing in of a quantity of rubbish is sometimes resorted to instead of a dam, but in many cases this will be found insufficient to effect the desired object. I know of a case at the present time where many tons of rubbish have been thrown into a mine for the purpose of checking the rising of water in the shaft, but where the force of water has been so great as to raise up the rubbish bodily. It is, therefore, extremely unlikely that you will be able by this means to check the rise of the water, and especially if the pressure be at all considerable. Under these circumstances it will be necessary to continue a dam in the shaft. In such cases suitable pumping machinery will be required to enable you to get down to ground where you can obtain the necessary foundation. Again, it sometimes occurs, though not very frequently, that old shafts subject to considerable incursions of water are met with, and if you are cutting a drift in the vicinity it may become necessary to put a dam in the old shaft to prevent the incursion of the water into your drift. If one were to take the history of any important colliery district, it would be found that many cases have occurred in which these dams have required to be put in, and, in fact, the men may be working at the present moment in full reliance upon their entire security This fact will afford sufficient evidence of the great importance attaching to the proper construction of dams. Wood and brick are the materials most commonly employed for this purpose. [Mr. Smyth then proceeded to indicate on the board the mode of constructing dams in shafts, when either wood or brick is the material selected.] There is one point, he continued, that should be mentioned, which applies to mines of all kinds, and that is, that as a great part of the water comes down from the surface it is very important to take off the surface water at as high a level as possible, so that you may not have to raise it from any unnecessary depth. In the case of a mine presenting no unusual difficulties, this may be readily done by means of an adit level. But, if you are dealing with a mine worked in successive stages or levels, as, for instance, most metalliferous mines, you may have a very considerable quantity of water at level No. 1, notwithstanding your adit level, and then it becomes a question whether it is better to pump it to the surface or to intercept it, and carry it off by the adit level. In some particular mines this may be a matter of life and death, as, for instance, a salt mine, where water from the surface, coming into contact with the bed of salt, would dissolve it, and thereby create fissures which would probably lead to the falling in of the surface, besides destroying a considerable quantity of salt. Hence in the salt mines of various parts of Europe it is usual to drive, if possible, above the bed of salt or near to it a level that will drain off as much of the water as possible. Another very curious circumstance is that it will frequently be found that a large proportion of the water cannot be entirely got rid of in any such way, and hence, in some kinds of strata, and in rock fissured by openings placed at anything approaching vertical, it may be that, although you may have intercepted a large quantity of water in the shallower levels, you may, notwithstanding, have to pump a considerable quantity from a lower point. Hence it is no matter for surprise that in metalliferous mines, notwithstanding these levels, you get large feeders of water at depths of 20, 30, 40, or 50 fms. It will be found that, as a general rule, by the time you have driven your 20 fm. level the 10 fm. level will have become nearly dry, and it has been almost universally observed that as you proceed to open out level after level the levels above, which may have been exceedingly wet, will be left completely dry, and the level below will seem to take all the water. You will, therefore, be at the disadvantage of having to lift it probably twice the distance, and, therefore, have to expend twice the power in doing so. Now, this is a very serious point indeed, and, therefore, miners are constantly on the look out when it is at all possible, to catch any stream of water which may still find its way down, and carry it off to the shaft, if you have the proper arrangements for pumping it to the surface, and so to prevent it from going to any unnecessary depth. Still the same thing may occur again in going further down, but it may be taken as a general rule that a greater portion of the water that has to be pumped out of a mine is really surface water—that is to say, the quantity of water given off from the strata does not, as a rule, by any means increase in proportion as you sink further down, but rather the contrary. Hence, if you have pumps within a short distance of the surface, of 18 in. diameter, you may expect, if you intercept the water whenever it is possible to do so, that when you get lower down the shaft pumps of lesser diameter will suffice. It is often the case, indeed, that starting with pumps of a calibre of 18 in., you may require, perhaps, pumps of a diameter of only 12 in. lower down, then 9 in., and, perhaps, down even to 8 in. pumps at the bottom, and in some exceptional cases the diameter of the pumps may be reduced even to as low as 6 and 4 in. It is not, however, always practicable to reduce the diameter of the pumps in this way, as you will now and then meet with feeders of an exceptional character, though feeders of water are frequently magnified in importance. In many cases the sources of these exceptional springs may be cut off, but in others it will be necessary to provide increased pumping power, and special provision may have to be made, which may interfere with the progress of the work, and in some instances may entirely destroy it in the end, but such cases are very rare. Nevertheless, you will remember that inasmuch as you will have to deal, as a rule, with a moderate quantity of water at an increasing depth, you will require a very powerful class of machinery if you have to go down to 200 or 300 fms. It is not the great quantity of water that is required to be lifted, but the great height of the lift, which renders necessary the employment of engines of a very powerful character. The mode of collecting the water for the purpose of its being pumped to the surface is to convey it along the levels by means of troughs to the nearest cistern in the shaft. These cisterns are placed at a certain distance apart, so as to accumulate the water coming from each level.

Having premised these few points, I will refer next to the methods which may be available in many cases where the amount of water is not very considerable, and which are also most commonly employed during sinking operations, and that is drawing it out of the shaft in barrels, varying in size from that of an ordinary kibble up to enormous barrels of sheet iron, carrying upwards of a ton of water. In some cases barrels of this description will be capable of raising all the water met with, whilst in others it may be necessary to be provided with pumps in addition. It may be that you will be required to keep something of this character constantly in action, but where the water is drawn in buckets or barrels it is generally looked upon as a temporary measure, and the work is generally performed during the night, as being the most convenient time. Having drawn on the board several examples of barrels employed for raising water in mines, the lecturer proceeded—Only last summer I had the pleasure of inspecting the details of a system of drainage upon, I suppose, the largest scale that has ever been attempted in this or any other country, and which is still going forward, in the neighbourhood of Newcastle-upon-Tyne, where barrels of a nearly similar form to those in common use in Staffordshire are used, and where they are endeavouring to re-open at the same time the Wallsend Colliery on the northern side of the Tyne, and the Hebburn Colliery on the southern side. The barrels, however, are much larger in size than those in ordinary use, being 16 ft. in length and 3 ft. in diameter, and are made of strong sheet iron. Each barrel is capable of holding 800 gallons of water, and no less a quantity than 1000 gallons per minute is constantly raised—night and day—from those collieries. This, however, may only be considered as a temporary expedient. It will be a question afterwards what amount of water can be permanently tubbed out, and what amount will have to be raised to the surface. Sometimes it may be necessary to employ apparatus of this kind independently of, or in addition to, the ordinary pumping machinery, owing to an extraordinary influx of water caused by heavy floods of rain and other circumstances. It is curious to note how soon floods will affect the quantity of water flowing into a mine. In the mountain limestone districts a heavy fall of rain will make its way down so rapidly that it is in reality a source of danger to the men working. In some of the mines in Flintshire one hears of its being usual to have a large bell accessible to the man at the surface, so that he may ring the bell at the bottom to give the men timely warning when a heavy shower of rain comes on. Now, it is a curious circumstance that in some mines the water takes months to get into the mine, but in others, as, for example, some of the Cornish mines, the winter rains will only make their appearance in the mine in the spring or summer, and hence it is customary to provide extra pumping power at those seasons. And now to the subject of pumps. I need not say that the construction of pumps for mining purposes has been one of the very highest importance at every period of the history of mining. In earlier times one of the most constantly occurring obstacles which presented itself, and owing to which a great many mines had to be partially or wholly abandoned, was the large quantity of water which entered the mines—not that it was impossible to lift it, but because it could not be lifted at an economical rate. A case is recorded, for instance, in which 400 horses were required to raise the water from a colliery where only 200 men were employed. In fact, in no department of mining has such progress been made as in the pumping of water to the surface. [Mr. Smyth then proceeded to explain, assisted by drawings on the board, some of the details of the construction of drawing and plunger pumps.]

Lecture XLIX.—The earliest pumps were drawing pumps, but their use was greatly restricted by the belief that the lift could not exceed the 32 ft. through which water can be raised by atmospheric pressure; but as the depths to which the shafts descended become greater, the ingenuity of mining engineers was stimulated, and experiments were tried which led to great results. The common suction pump was converted into the more useful drawing or bucket-lift pump, by the simple expedient of increasing the height of the collar above the piston, and making the bucket-rod work inside a column of pumps, and lift the water above it. At every up stroke of the rod the water rises through the clack or valve piece, and the column of it standing above the bucket will be so raised as to deliver at the top of the lift a quantity measurable by the length of the stroke. The water is delivered into a cistern, and then another lift lands it in a cistern above that, until the surface is reached. It was early found desirable in deep mines to substitute for buckets a forcing arrangement in all but the bottom lift, and this was perfected by Capt. Lean in 1801 by the introduction of the plunger-pole. This is worked through a stuffing-box into a plunger-case of cast-iron, and forces at every down stroke the water through an upper clack and the clear column of pipes above it. The great advantages of this plan are—first, the smaller amount of wear and tear; and, secondly, that the engine has simply at each stroke to lift the rods and plunger-poles. As I have already intimated, with the plunger-pump the first lift from the bottom is generally a bucket-lift, and for the reason that they are always subject in the bottom to delays of various kinds, which allow the water to rise a few fathoms in height. If the water rises over the clack-door it is a matter of small importance, and when the machinery goes to work it soon comes right, and also if the clack be out of order the men are able to put in a fresh bucket, or put in a fresh clack through the pipe at the bottom, which, being 30 or 40 fms. in height, gives a sufficient margin. If they had a plunger-lift at the bottom, and the water was then to rise over the clack-door, they could not get at it in the same manner to replace the part if anything got out of order. In such a case that lift would be lost, they would no longer be able to draw water from below that point, and they would either have to give up working it, or put down another lift by the side of the damaged one, so as to draw off the water, and allow of its being put right again. Then, if we take into consideration how these pumps are to be worked on a large scale, we shall see their advantages. Formerly each pump used to be worked by a separate main rod, but if the rods are of sufficient strength there is no reason why they should not all be attached to and worked by one main rod. That plan is now frequently adopted, and particularly in the Cornish mines. Thus a main rod passes to the bottom of the workings, and to it will be attached the different rods or plungers of the intermediate stages, and so with one stroke of the main rod the water is forced up by several lifts to the surface of the ground, where some of it is reserved for the use of the engine, and the rest goes off by an adit level. These lifts have each a particular name—as the house-lift, the tie-lift, the hose-lift, &c. At the bottom the bucket-lift is employed to bring up the water to the first cistern, from which it is taken by the lowest plunger, and raised as I have described. As the lift increases in length there must be increased precautions against the bursting of pipes and the leakage of joints, which has probably been the reason why wooden lifts have gone out of use, and cast-iron substituted. Iron, however, is an inconvenient material where water is inclined to be acidulous or saline, the effect of which is to produce an ochreous deposit, and in some cases the iron will become so soft in the course of a year that it may be cut with a knife, like plumbago. In the Cornish mines, where these results are frequent, and often very troublesome, the pipes are lined with a coating of wood to prevent the water coming into contact with the iron. In the older mines they often employed gun metal for the working barrel, which was found to last for a great length of time. In the present day, with the larger size of the pumps, and the greater strength required, gun-metal would be too expensive, but notwithstanding there are a few mines where the water is highly charged with corrosive minerals, in which brass is used. At the Parys Mines, in the Isle of Anglesey, lead was tried in certain parts of the pumps in order to withstand the effects of acidulous water, but eventually it either had to be given up altogether, or adopted on a very small scale. While it has been found a matter of great importance to lengthen these lifts, so as to diminish the number of joints and places which require constant attention, and in some collieries in the North of England they are as long as 100 fms., such joints as remain have to be constructed with greater care, and of much more considerable strength. Indeed, when water is forced 100 fms. in height, it is obvious that the pressure to be resisted will be serious. The main rod, on which the action of the whole of the work depends, must be placed with a view to convenience as regards points in the shaft where good bearers can be obtained to carry a portion of the weight of the cistern. These bearers are sometimes formed of ledges cut in the rock, but where the shafts are lined with cast-iron it is usual to make the bearers part of the mass, and so form one casting. Where great depths are attained, and wooden rods are used, they are made to taper in the same manner, and for the same reason as in the case of ropes. Thus one may start with quite a thick beam, or two strong balks of timber placed side by side and bolted together, but becoming smaller as it goes down. And in a deep mine a main rod of 200 fms. long is made for the first 150 fms. of two 12-in. square Riga timber balks, and afterwards of one 15-in. balk, decreasing to 14 and 12 in., and then to 8 in., until it gets down to the bottom, and the bucket-lift is attached. At the requisite intervals the plunger-poles are attached to it by sets-off, bound to it by strong staples of iron. The several lengths of rods, generally from 40 to 70 ft. in length, are connected by the aid of strapping plates or cheek pieces of wrought-iron, the very best in quality that can be procured, from 9 to 12 ft. long, on opposite sides of the rod, bolted through it with screw bolts. Stays are placed in the shaft at intervals to guide the motion of the rod, and iron rollers are added where it deflects from the perpendicular. When the rods are of this vast magnitude, and the depth of the pit is from 200 to 300 fms., the weight of the main rod, with the apparatus and machine to it, will range from 40 to 60 tons, and thus the mere dead lift will be a serious thing for the engine power. To meet this the ordinary system is to counterpoise this weight by what are called "balance-bobs." These have been applied in one form or another from an early period, and in the Model Room there is a model by Jordan showing some ingenious varieties. The same principle is applied to water-wheels and fly-wheels, where heavy weights are attached at opposite sides, so that the revolution is assisted at the points where the greatest strain is felt. Balance-bobs are applied not only at the surface, but at intervals down the shaft, if it is very deep. They consist of a strong beam, at the end of which is a box filled with ironstone, scrap iron, or anything heavy, and weighing from 15 to 30 tons. The other end of the beam is attached to the rods, and thus while the greater weight of the rods in the descent raises the balance-bob with ease, the latter, when the up stroke comes, acts as a counterpoise to the weight to be lifted. The value of this arrangement will be clear if I just quote the case of one of the shafts, 348 fathoms deep, at the Tresavean Mine, in Cornwall, in which the plungers and sets-off weigh 67 tons; the main beam, with its connections, &c., 50 tons; four balance-bobs, 60 tons; four loaded balance-boxes, 80 tons: making a total, besides the weight of water in the drawing-lifts, of 260 tons, to be set in motion at every stroke of the engine.

Although the rods are always made with the greatest care and of unusual strength, serious results occur from their breakage, which may arise from the decay of the timber, or, from long working, getting out of the perpendicular, or the rusting of the bolts when they pass through the wood. In order to guard against such accidents we must consider how they are likely to occur. The upper extremity has the whole weight of the rods to bear, and if a breakage should occur, the strain being suddenly lessened by the weight of the piece broken off, the beam would strike back into the engine-house, break the piston, and knock the fittings and buildings to pieces. The expense of replacing all these would not be the whole cost of such a catastrophe, as it would probably cause the suspension of the works for a considerable time, besides which loss of life more or less extensive would be almost inevitable. In order to obviate these dangers strong catches are put in the shaft, so that the sudden rebound of the released upper beam might be prevented. But the lower portion of the fractured rod would also cause great damage and trouble, as by its own weight it would carry everything before it, destroy all the fittings in the shaft, and smash every bucket to pieces. To prevent this, suitable places are selected in the shaft where also "catches" are applied, and strong pieces of wood are strapped on to the main rod, so that if suddenly detached the falling piece would be brought up within a given space. This is an important precaution as regards the fahrkunst, or man engine, because if the rod broke the results would be fatal to all persons in the shaft, while by these "catches" such a catastrophe would be prevented.

Another important adjunct to the appliances for raising mineral in the shaft is the "angle-bob"—a contrivance very like in its principle and character to a bell-crank. Supposing we have a shaft sunk vertically to a certain point, and then, following the underlie of the lode, the angle-bob comes into play in order to get the load passed by the angle in the shaft. [Mr. Smyth, by means of the board, delineated the mode in which this contrivance is made available, and the recesses cut in the ground to make room for it.]

The pit arrangements and pitwork of the Cornish miners have been brought to a high state of perfection, and so in like manner the Cornish engine has been found to be the most efficient application of steam power for the work of pumping. I have already stated that a Bolton and Watt engine attained a high degree of perfection towards the end of the last century, when, by the consumption of 94 lbs. of coal, 17,000,000 lbs. of coal could be raised a foot high. Watt himself thought improvement could go no further, but the engine constructors and engineers commenced a system of friendly rivalry, and in the next 30 or 40 years the "duty" attained was about 50,000,000 lbs., and since then a duty of 100,000,000 lbs. has been reached. This surprising result was brought about in a great measure by the emulation fostered by the monthly reports of the work done by different engines being published periodically. I have before me one of these reports for December, 1868, which gives every detail respecting the various engines, and then calculating of what is done by a given amount of fuel. The *Mining Journal* also gives every month in its columns the amount of useful work thus attained by the expenditure of a certain amount of coal; and thus

every engineer sees what his neighbour is doing, and whether he himself is up to the mark. I am sorry, however, to say that, as a rule, the duty of late years has not increased—indeed, it is the reverse. This is partly in consequence of bad times, which have made directors begrudge the small sums necessary to keep the engines in a proper state of repair, and partly, perhaps, because the mines are not frequently enough visited to see if everything is in proper order. On looking over the list in my hand for the last month I see the duty ranges most frequently from 49,000,000 up to 52,000,000 lbs., and I think only one comes up to 71,000,000 lbs. At any rate, you will in this way, by looking through these reports, be able to say what work a well-constructed engine is capable of performing, and a knowledge of that point is not only desirable for those who have to work with engines of this kind, but important for everybody who has anything to do with mining at all. Indeed, it is to be regretted that the writers for the press, who pretend to discuss scientific and practical matters, should not inform themselves somewhat more accurately of the facts they are writing about. Nothing could be more absurd than some of the statements in the papers (amongst which the Times distinguished itself) respecting the celebrated salt mine of Wellicska, which is said to have been broken into by an underground river at a depth of 110 fms. from the surface. The real facts about the inburst of water into the Wellicska Mine seems to be that if they had been properly provided with pumping power there would have been no danger, and need have been no alarm. Any Cornish or Northumbrian mining engineer accustomed to deal with water would probably have avoided the danger; but it is satisfactory to find that the influx is capable of being easily kept under by what we should call an engine of very moderate power.

As regards the pumps which do the work in our mines, it is not very commonly the case that the engines have cylinders of larger diameter than 60 in., but there are plenty of instances in which they reach 90, and sometimes 100 in. In Cornwall they now prefer to reckon the power of an engine by the diameter of its cylinder than by horse power. If they know the diameter of the cylinder and the length of stroke, they know what the engine ought to do. Hence the most powerful engines may be set down as being 100 in. in diameter, and from 10 to 12 ft. stroke.

There is one other point respecting this gigantic machinery to be noticed, and that is the main beam, from the end of which all the vast weight of rods, plungers, &c., is suspended. This, of course, must have a corresponding strength. It has usually been made of two pieces of cast-iron, varying from 30 to 40 ft. in length, held together by two cheek-pieces, and weighing altogether 40 or 50 tons. This enormous amount of metal is to be added to that which I have mentioned as set in motion at every stroke of the pump. Within a few years several serious accidents have occurred in consequence of a sudden fracture, and especially I may mention that which occurred at the Hartley Colliery. In that case the beam was made of cast-iron, and the larger fragment which broke off unfortunately fell down the shaft, smashing all the bratticing and machinery, as well as destroying the ventilation, and there being no other means of egress, 204 persons lost their lives. Since that sad catastrophe a considerable number of engine beams have been made of wrought-iron, and various new modes of construction have been adopted; as, for instance, at Clay Cross, in Derbyshire. The engine there has a cylinder of 84 in. in diameter, with a stroke of 10 feet. The beam, which is 36 ft. in length, and 7 ft. deep at the centre, is composed of two rolled iron slabs, rivetted together. In other cases the beam is built in sections of boiler-plate and angle-iron. These plans have been adopted with great advantage, not only as regards security from fracture, but also, when a beam has to be sent to any considerable distance it may be taken with safety, whereas cast-iron is always an uncertain material, and if subjected to a sudden shock or a fall upon a quay, it is easily fractured, involving a great loss of time and money. Under such mischances wrought-iron is likely to remain uninjured.

[Mr. Smyth concluded by recommending the students to give a close inspection to the models of the various kinds of pumps, of which there is an admirable collection in the Museum.]

LECTURE L.—In our last lecture I endeavoured (said Mr. SMYTH) to place before you some of the leading features of the arrangement of pumps in shafts, pointing out the great importance which attaches to the guides and the counter-balances of the great weights which necessarily result from the manifold connections of the main rod, and the lifts attached to it. I also mentioned the great perfection attained in the Cornish mining districts from the adoption of the plunger-pump, by which the great weight of the rods is made available for producing the down-stroke. You would have observed that in the Cornish system of pumping even the great water-wheels are carefully balanced, and thus, when they are at their greatest disadvantage in the dead part of the revolution, balance-bobs are attached to help and pull it over. The power of water-wheels may be frequently rendered applicable to the working of mines, although at a considerable distance from where it is brought to bear on the pump. Thus it is frequently the case in hilly districts, and especially in South Wales, that a shaft will be sunk in one valley, and the water power is obtained from another valley at a higher altitude, being made available by the intervention of a series of rods, called horizontal or flat-rods, suspended or worked on carriers. [Mr. Smyth, by a series of delineations on the board, showed how this was done.] Arrangements of this kind are often incomplete and unsatisfactory, because of the crooked condition of the levels, but they must be judged by the actual amount of duty performed by these auxiliaries. Within the last few years a proposition was made by Messrs. West and Darlington to introduce hydraulic engines instead of horizontal rods, which, where applicable, are likely to be a matter of great convenience in many mines. By this plan the main rod and plunger works into a plunger-case, and that plunger-case is connected with the line of horizontal pipes along which the water is forced, and lifts the rods at the other end. I have seen this employed at a distance of 140 fms. satisfactorily. If the power has to be carried otherwise than in a horizontal manner, it will be done simply by the intervention of angle-bobs. In this way a large wheel at the Great Devon Consols is worked by the water of the River Tamar at a distance of between ¼ or ¾ mile by the intervention of rods 2½ or 3 in. in diameter, made of the best wrought-iron, and this transference, which it is often extremely convenient to make, is effected without much loss of power.

Mr. Smyth then proceeded to mention particular districts where the calibre of the pumps themselves are of unusual magnitude—as South Wales, 26 in. in diameter; Shakemantle, in the Forest of Dean, 26 in.; Hartley, in Yorkshire, 30 in.; and Alport, in Derbyshire, 42 in., looking like a shaft full of water rather than a pump. Pumping machinery of this gigantic size was, however, frequently insufficient, and the only way of dealing with such heavily-watered districts was the construction of those great adit levels which he had described in a former lecture. He also supplemented what he had said respecting Cornish engines, by speaking of the tubular systems of boilers introduced by Mr. Trevithick and Mr. Fairbairn, the plan of jacketting the cylinders and boilers, and various other contrivances for economising fuel and retaining the heat.

Mr. Smyth then continued—I turn now to another part of our subject, without which all the other appliances would in many cases be utterly useless, and by far the larger amount of minerals raised in this country would remain undisturbed in their primeval beds—the subject of ventilation. It is scarcely necessary to point out that, whether workings are carried on vertically or horizontally, there will after a time be a period when the men cannot work in consequence of the air becoming stagnant, unless there be some artificial and systematic contrivance to renew the atmosphere they breathe. The reasons for this are manifold, but we can only glance at them. This stagnant air is coupled with an increased temperature, increased humidity, general vitiation by the burning of lights, by the breathing of men (and horses if any be employed), and by the explosion of gunpowder. Besides these many of the minerals cut through have chemical affinities which absorb the oxygen from the air, while carbonic acid gas and fire-damp are in some strata continually exuding. All these conditions have more or less to be combatted, but, as a rule, what is done in the way of ventilation must be guided by the specialities of each case. Thus, in some instances there may be a very small number of men and lights in a mine, which would obviously require less powerful ventilation than a colliery, where the reverse is common. Suppose we first consider what is wanted in a metalliferous mine. At each working place there will seldom be more than two or three men engaged at a time, and frequently there are several shafts open at no great distance from each other. It may be, then, that there will be plenty of air without artificial appliances at all, and it will only be when the mineral is worked away in large quantities, and a number of men are brought together in a small space, that they will require additional air, supplied from a different source. The case is wholly different in working out a stratified bed. It will be seen (referring to a large plan of the Lund Hill Colliery) that all the workings have to be supplied from two pits, the air flowing in a large unbroken stream down one and up the other, having in its journey been made to visit all the places of work both near and far. If the colliery be on what is called a fiery seam, from which there is a large exudation of fire-damp, that will furnish an additional reason for carrying a large quantity of air through all its ramifications. It is obvious that this can only be done by adoping a regular settled plan, thoroughly carried out, and unremittingly supervised, and involving a heavy and continual expense. In dealing with the various difficulties which beset the miner in connection with ventilation, it is necessary to be acquainted with the properties not only of the atmosphere, but of the noxious gases which are generated in the mines—their fluidity, their weight, and the place they occupy in relation to each other. The atmosphere is said to grow "bad" or "poor," when, being stagnant, the oxygen in it becomes exhausted, and there is mingled with it an unusually large proportion of carbonic acid or sulphuretted hydrogen, arsenical vapours, coal dust, gunpowder smoke, and other impurities. I may refer you on this subject to the very careful report by Dr. Smith, of Manchester, to the late Royal Commission which sat on metalliferous mines. It is a complete work in itself, and gives a vast number of analyses of the air in various mines, 80 per cent. of which showed a vast deterioration by the loss of oxygen, and the increase of carbonic acid gas. The ordinary composition of the atmosphere is oxygen 21 per cent., nitrogen 79 per cent., with a slight subtraction to be made from the oxygen of carbonic acid, 0·04. In mines, however, the oxygen comes down to 19 or 18, while the carbonic acid is increased to one-tenth per cent., and in some instances 1 and 2 per cent. Samples were obtained in which there was much more than that, but they may be put aside as not fairly representing the ordinary condition of the mines. The deterioration of the air in mines is not a subject of recent observation, and it is frequently discussed in the works of old authors. One of them, Dr. Platt, of Staffordshire, mentions a particular sort of gas, which he calls "pea-blossom damp," probably from its being observed at the time peas are in blossom. The miners call everything damp—black-damp, white-damp, choke-damp, fire-damp, globe-damp, and so on—details into which we need not now descend. Let us look rather at the relative specific gravity of the principal constituents in the order in which they exist in a mine level. The lecturer then tabulated them upon the board:—First came water, which flowed along the floor of the level; next came sulphurous acid; upon that would be found carbonic acid (specific gravity 1·524); above that atmospheric air, occupying, as it were, the middle line; next in order came carbonic oxide (specific gravity 0·970); above that would occur sulphuretted hydrogen, the hydrogen of which the specific gravity was 0·976; and, lastly, carburetted hydrogen. If they had to consider the gases as occupying different portions of the mine they must recollect—for this was a point most absurdly neglected—that if any of these lighter gases happened to be present in the deeper workings than those he would suppose the men to be working in, they would have a tendency to rise up, so that if they had a seam of coal or shale, which gave off carburetted hydrogen below a well of water, such as a sump, the lighter gas would rise through the water, and get into the workings above. Many explosions had occurred from ignorance of this, it being generally supposed that water was a positive barrier to the passage of gas. This was a very fallacious notion, as was proved by the circumstance that gas had, in some cases, bubbled up through a deep river, and been set fire to at the surface. The burning springs afforded examples of this phenomenon. The first gas they had to deal with was carbonic acid, which, from its great specific gravity, was always inclined to accumulate in the lower workings. If this gas were present in the proportion of from 5 to 8 per cent., combustion was rendered difficult, and if it became as much as 10 per cent. the candles would go out, and any proportion beyond that was dangerous to life. An extraordinary instance of the presence of this gas in considerable quantities occurred at a colliery at Pontgibaud, in Central France, where the most powerful ventilating apparatus was required to carry it off, notwithstanding which the men were occasionally obliged to leave their work on its account. This was an exceptional case; but, nevertheless, in many of our collieries they might have such an exudation of this gas as to put out the lights. Nevertheless, when it is present in smaller quantities, and the men are exposed to it during their shift of six or eight hours, they come to the surface with a splitting headache, which they do not get rid of for many hours after. There is a district of Auvergne, where they are particularly subject to the evolution of this gas, and there are cases of old workings out of which it comes very freely. The miners sometimes get rid of it by violent mechanical means, or they bring in burnt lime and throw down to absorb it, or a jet of high pressure steam, if at hand, may be turned in, but the most practical way is a good current of fresh air. Sulphuretted hydrogen was a most poisonous gas, but it did not often occur; it had been recognised in the Whitehaven collieries, where it was given off by a decomposition of iron pyrites, and bubbled up from the old workings. In the Townly Colliery the men cut into a feeder in the stone drift, which contained a great deal of this gas, but it was nowhere found if the water were fresh. The middle stratum was composed of the common air or atmosphere, of which he had already spoken. Nitrogen might be described as the atmospheric air deprived of its oxygen. Carbonic oxide was a production rarely to be met with in collieries, but it should be guarded against, on account of its poisonous properties: and it was strongly suspected, if not proved, to have existed in the mine at the time of the great Hetton explosion, some years ago. Carburetted hydrogen was what was here called fire-damp, and was designated by the French miners *grisoux*, and by the Germans *schlagendus wetter*. If it exuded in a pure state it might be set on fire without danger, and it burned with a pale blue flame; but if it were mixed with from four times its bulk of atmospheric air it would explode, and most violently when there were from seven to nine times its bulk of air mingled with the fire-damp. Those accustomed to fire-damp were aware of its different qualities and powers, according to the proportions in which it was present in the air. But other gases were often mingled with it besides common air, and, therefore, their judgment could not always be depended upon for safety. It was often given out from the coal by simple exudation, in which case its quantity could be calculated, and its removal regularly provided for by ventilation. But sometimes, in certain portions of a coal seam, and particularly in the neighbourhood of faults, it occurred in the shape of blowers, when it poured into the mine in quantities so incredibly large as in a few minutes to fill the whole of the workings, and then, if the ventilating arrangements were not what they ought to be, or the lamps of the miners were in bad condition, or naked lights within its reach, there must be a great calamity. This gas, from its specific lightness (0·55), had a tendency to accumulate in the higher parts of a mine, and no light ought even to be allowed to go into the higher workings without each place being most carefully examined by the proper officer of the mine for that purpose. Wherever there was laxity in this respect there was danger. In metalliferous mines this gas seldom occurred, but remarkable instances of its presence did transpire from time to time, when the ground approached the character of the coal measures, and in the black shale and other beds connected with the carboniferous limestone. Cases of this kind had occurred in the Hartz, at Talargoch, and more recently in Flintshire and Montgomeryshire, and at Okel Tor, on the banks of the Tamar, where a reservoir of carburetted hydrogen was suddenly broken into, and an accident occurred. It had been stated that this gas was sometimes associated with some of the arsenicated gases, in which case it must be extremely pernicious; but this had not been satisfactorily proved. Considering how much decomposition of material went on in mines, the presence of such gases was, however, extremely probable. Besides these gases watery vapour was also present in mines to a great extent, and it was as much desirable to get rid of that as of the deleterious gases.

I mentioned in a former lecture (concluded Mr. Smyth) that where there was a liability to sudden outbursts of fire-damp, the use of the safety-lamp ought to be imperative throughout the whole mine; and that even safety-lamps must be used with great caution, because if exposed to a current of more than 6 ft. in a second they were no longer secure. Experiments to a great extent have lately been carried out in the North of England, and several new modifications of the Davy and Geordie lamps have been proposed for the purpose of giving thorough security in the midst of the greatest currents. This, however, has not yet been satisfactorily accomplished, and we must still look to ventilation, properly devised and well carried out, as the best means of safety, for the best lamps will get out of order, or be unlocked or tampered with by the workmen. Ventilation, then, is the first element of safety; but the safety-lamp must also be employed when there is a liability to blowers and outbursts of carburetted hydrogen.

LECTURE LI.—Referring to the remarks made in a former lecture, when the subject of lighting the mines was discussed, Mr. SMYTH said that they would have probably arrived at the conclusion from that and from other incidental facts which had oozed out in passing, that in a certain class of mines the greatest enemy the colliers had to meet was the fire-damp; and now they had arrived at the subject of ventilation it would be seen that the only really practical mode of dealing with fire-damp was the introduction of large volumes of fresh air sweeping through the workings, and carrying off to the surface this dangerous gas. One great reason why fire-damp was so difficult to deal with was that its mode of occurrence could never be depended upon. Thus, in certain seams there would be what he might call a regular exudation of the gas from the coal or shale, as the case might be, in the levels, and at the face of the workings, and the ventilation might be abundantly sufficient to meet that state of things: but there was never any absolute certainty for an hour that that state of things would continue, as the men might in bringing down the coal set free a pent up reservoir, as it were, of gas, which might fill the whole mine, and endanger the lives of every person in it. These "blowers," as they are called, are more frequent in some seams than others, but in fiery mines their occurrence should always be looked for and provided against. The workmen ought to be well instructed what to do in such cases; the lights should be instantly put out by drawing down the wicks, and not by a puff of the breadth, which would be, perhaps, the most natural course to take, but which, by blowing the flame through the gauze of the safety-lamp, might occasion an explosion. As a rule, in fiery mines none but safety-lamps ought to be used. There are many cases on record in which a sudden blower has completely filled a mine, but the men being careful, and the lamps in good order, no accident has happened, and the ordinary ventilation in a short time has restored the atmosphere to its usual condition. George Stephenson, the inventor of the lamp known by his name, has left on record a series of important and interesting experiments with respect to blowers and the exudation of carburetted hydrogen. He had early noticed that the emission or non-emission of gas from the coal in a mine is often greatly effected by barometrical or rather atmospheric pressure. Thus, when the barometer showed an increased atmospheric pressure it was found that the quantity of gas given out by exudation was greatly lessened; and, on the other hand, when the atmospheric pressure was not so great the exudation was much larger. This was found to be the case particularly when the effects were observed upon some continuous blowers, the natural jet of gas being kept entirely back in certain states of the atmosphere. The barometer, therefore, is a most useful instrument to be kept both in the mine and at the surface, and its rise and fall should be carefully and systematically watched and noted. One great source of danger in fiery mines is the use of naked lights in one part of the workings, while in other parts of the same colliery none but safety-lamps can be employed. The workmen are always ready enough to dispense with the safety-lamp, which is so far disadvantageous that it has a much less illuminating power than a naked light; but although there will often be portions where the use of the latter is safe, the men are apt to forget the boundaries between safety and danger, and probably a large proportion of those terrific accidents which now and then occur, leaving no survivor to tell the tale, may be truly attributed to this source.

In dealing generally with the subject of ventilation, it is necessary to consider first that which may be called spontaneous ventilation, and which, in metalliferous mining, might almost be called the usual and ordinary mode of supplying air to the mines. If we descend (said Mr. Smyth) below the surface of the earth to a tolerable depth, we shall find the atmosphere no longer affected by the changes of winter and summer, and at 60 or 70 fms. the degrees of warmth are invariable. Below that depth there is an increase of heat the deeper you go, and this is the case in every region of the world. The rate of increase is not the same, but differs in different classes of rock, and in different kinds of mine. Thus a tin mine will be cooler than a copper mine, and granite will be cooler than the shale of the coal measures. The lowest rate of increase is 1° in 90 ft. of depth, and the highest, 1° in 40 ft., but, as an average, the temperature is found to increase at the rate of 1° for about 60 ft. Henwood, in his interesting work on the "Mineral Veins of Cornwall," gives some useful details on this point, and Prof. Wright and Mr. Fairbairn carried out important experiments in the deep mine at Dukinfield—the deepest of English mines with regard to internal heat. They found that the mean temperature of London and Edinburgh was as follows:—London, winter, 39·5; summer, 63—Edinburgh, winter, 38·5; summer, 58; and consequently, taking also the temperature of certain mines in different districts, we may come to some conclusion as to the mean temperature of England and that of underground workings. This difference of temperature between the air at the surface and the air below is the cause of natural or spontaneous ventilation. Supposing two shafts to be sunk, and to be connected with each other by a level underground, each shaft may be taken to represent a column of air, and if one should be shorter than the other, which may easily happen from inequalities of the surface, a current is at once set up. Thus, in summer the air in the longer shaft will be the cooler, and displacing that which is warmer at the bottom, it will be forced along the level and up the other shaft. In winter the effect will be reversed, and the warmer air will be expelled from the top of the taller shaft. This process in a very large number of cases goes on without any help by artificial means, and we shall see that there are mines through which very large quantities of air are circulated in this way. These are chiefly in the hilly districts of Devon and Cornwall, and of some other counties where the workings are not subject to fiery gases, and the deterioration of the air arises chiefly from the vitiating effects of the breath of men and horses, of the combustion of candles, of gunpowder smoke, and from various impurities of that kind.

There are many artificial aids (generally speaking of a simple character) by which spontaneous ventilation can be made more effective and manageable. Where the two shafts are so nearly on the level as to render the action doubtful or uncertain, one of the oldest remedies, and one used to this day, is the application of horse-heads or cowls at the top of the shafts. If we turn to the ancient work of Agricola we shall find a great variety of contrivances of this nature, which were in vogue in his time. Amongst them is the simple application of boards arranged so as to turn the wind down the shaft. When, as in trial works, there is but one shaft, divided down the middle with a brattice, horse-heads or tub-vanes are put up, and the mouth of one kept facing the wind, and the other in the contrary direction, the air thus being carried down by the one, and up by the other. Another contrivance is called the barrel-vane, in which a barrel is set on end (or a square box instead of a barrel), and mounted on a spindle, and then attached to the end of the barrel is a vane, which always keeps the head of the barrel towards the wind, which is passed through the barrel down a pipe into the shaft, and so up again by the other division. Cowls are very much used elsewhere than in mining, as if you go to the top of this building you will see some on a very large scale made of sheet-iron to ventilate public rooms and institutions. A second cowl is often employed for the purpose of getting rid of the foul air brought to the surface by the upcast, and if any wind be stirring at all this is a very easy method of effecting that purpose. Another device frequently used, in addition to the others I have mentioned, is that of building a tower or stalk over one of the shafts to destroy the equilibrium of the respective columns of air, and establish a current. Next comes the introduction of various methods by which the current of air thus obtained are conducted to the workings, or separated right and left at various points for that purpose. Supposing we were driving an adit, we should find that at a certain distance from its mouth the air would be deficient in quantity, and vitiated so much that the men could work in it no longer without the aid of artificial ventilation. At first the air would naturally have a tendency to come in along one side, and go out along the other side of the level, but eventually this action would cease. What, then, is to be done? Perhaps, if the hill be not very high, the best course would be to sink a shaft to that point, which would set the air in motion, and allow the level to be carried still further. After a time, however, a similar stagnation will occur, and then another air-shaft must be sunk, in which case the first must be closed, or the air would go up the nearest, but this being done, you compel the air to circulate through the second shaft. Perhaps, it might be necessary to put in a door and a tube or air-pipe, so that it cannot get out until it has performed its allotted journey, and then it may be allowed to rise by the side of the pipe and escape. As a general rule, air-pipes are used only in exploratory workings, and when the number of men to be supplied is but small—say, from two to six—and they may be as contracted as 6 in. in diameter, but they should really be larger if circumstances will admit. They are usually made of wood, carefully fitted, and the joints clayed so as to render them air-tight. Of late years cylindrical zinc air-pipes have been used largely for these purposes, and although they are advantageous in respect to the ease with which they can be put up, they have the drawback of being easily damaged. Other materials have been tried, as, for instance, *papier mache*, but it was found liable to become softened and to fall to pieces. Wood or zinc are better than either; cast-iron is now generally used, but the weight of the latter renders it necessary that pipes of it should be laid on the floor. As regards size, the larger the pipes are the more efficient will be their work, as it should never be forgotten that the power to labour, as well as the health and sometimes the lives, of the men depend upon that small pipe. In coal mines they do away with pipes as early as possible in order to employ the levels themselves for ventilation, so that instead of a tube of 6 in. diameter, the air passage is 6 ft. by 6 ft., through which large volumes of air are introduced.

GEOLOGICAL SOCIETY OF LONDON.

April 28.—Prof. T. H. HUXLEY, LL.D., F.R.S. (President), in the chair.

Daniel Jones, of Donnington, near Wolverhampton, and Thomas Heathcote Gerald Wyndham, Fellow of Merton College, Oxford, of Sock Dennis, Ilchester, were elected Fellows of the Society.

The following communications were read:—

1.—"On the Geology and Mineralogy of Hastings County, Canada West," by T. C. Wallbridge: communicated by Dr. Percy, F.R.S.

Before describing the gold and iron ores of Hastings, which formed the main subject of this paper, the author introduced a general sketch of the geology of the county. After noticing certain local deposits of recent origin, he described the extensive accumulations of drift-gravels and boulder-clay. A single boulder near the Shannonville railway station was said to cover an area of about five acres, and to have a thickness of 100 feet. The evidences of glacial action over the whole country were referred to, and the direction of ice-marks cited from several localities. Below the post-tertiary deposits the rocks consist, in the southern townships, of Lower Silurian limestones, referred for the most part to the Trenton group; and in the northern townships of a large series of metamorphic rocks, supposed to be of Lower Laurentian age. Bosses of syenite and gneiss penetrate the Silurian beds to the south of the main Laurentian mass, and several outliers of Trenton limestone point to the former extension of the Silurian rocks northwards. All the minerals of economic value are confined to the Laurentian area. Gold was first discovered in the county of Hastings in 1866. The author described in detail the singular occurrence of the metal in the Richardson Mine, at Madoc, where it was found in two pockets, associated with a peculiar black carbonaceous substance, a ferruginous dolomite, and ochre-brown iron ore. Assays of the surrounding rocks showed the existence of gold even at a considerable distance from the mine. Mention was also made of several other gold mines in Madoc, Marmora, and Elzevir, from which specimens were exhibited, and analyses of ore quoted. The iron ores of Hastings occur partly as magnetic oxide, and partly as hematite. In addition to the well-known "Big Ore bed" and the "Seymour bed," the writer called attention to some new localities of magnetic ore in Madoc. The deposit of hematite called the "Kane Ore bed" was discovered by the author some years back; and from ancient workings in this bed (apparently those of Indians, who may have used the ochre as war-paint) he has obtained bone-needles and other objects of human workmanship. Attention was then directed to a large deposit of specular iron ore in Hungerford, hitherto undescribed, and to the pyrrhotine or magnetic pyrites of Madoc. The paper concluded with a notice of the galena and other less important minerals of the county.

Prof. RAMSAY enquired as to the proof of the existence of so large a boulder as one of five acres in extent. Under ordinary circumstances, large boulders fell from higher rocks on to the surface of glaciers beneath, and were by them transported to the places where now found; but the fall of such a mass seemed almost incredible. He suggested that possibly it might be an outlier of the Lower Laurentian beds.

Mr. DAVID FORBES stated that the results of his own examination of some of the specimens from the gold mines of this district did not quite tally with those recorded in the paper, especially those of the rocks in the neighbourhood of the veins. He considered gold in Canada was confined to the veins.

Mr. PRESTWICH cited the discovery of a boulder between Stamford and Peterborough, which was at least 400 ft. in length, and consisted of a mass of great oolite.

Mr. SEARLES WOOD mentioned a boulder of marl in the Coast Section near Cromer, upwards of 300 yards in length, and 60 ft. in height.

Mr. WALLBRIDGE, in reply, stated that the rock must have come, at the least, 20 miles from its original home. The surface of the Trenton limestone rock in the neighbourhood was striated in the direction of the boulder. There was no evidence of intrusion. The mass was traversed in two or three places by crevices.

2.—"On the Distribution of Flint Implements in the Drift, with Reference to some Recent Discoveries in Norfolk and Suffolk," by J. W. Flower, F.G.S.

On Wednesday the following communications will be read:—1. "On some of the Results arising from the Bedding, Joints, and Spheroidal Structure of the Granite on the Eastern side of Dartmoor," by G. W. Ormerod, F.G.S.—2. "On Apparent Lithodomous Perforations in the Hills of North-West Lancashire," by D. Mackintosh, F.G.S.—3. "On the Parallel Roads of Glenroy," by James Nicol, F.R.S., F.G.S.—4. "On Supposed 'Rothliegende' Beds near Knaresborough," by J. Clifton Ward, F.G.S.

MECHANICAL VENTILATION OF COLLIERIES.—At the Institution of Mechanical Engineers meeting, Mr. JAMES S. E. SWINDELL, of Stourbridge, read a paper descriptive of Guibal's Ventilating Fan, employed at the Homer Hill Colliery, Cradley. The fan has eight vanes, and revolves on a horizontal shaft within a cylindrical casing of brickwork, by which it is completely enclosed at the sides and circumference, with the exception of a circular aperture in the centre of one side for the entrance of the air from the mine, and an outlet opening in the circumference for the discharge of the air into the outlet chimney. The area of the outlet opening is regulated by an adjustable sliding shutter, according to the extent of ventilation required; and the outlet chimney is built with a gradually increasing area up to the top, so as to reduce the velocity of the air at the point of discharge, and thereby prevent the loss of power that would occur in discharging it at the velocity of the fan. The fan is driven direct by a horizontal steam-engine, working a crank on the end of the fan shaft, without the intervention of any gearing. The fan at the Homer Hill Colliery is 16½ ft. in diameter and 4½ ft. in width, and its usual working speed is 26 revolutions per minute, discharging 13,500 cubic feet of air per minute; and it can be got up in only about one minute's time to the higher speed of 96 revolutions per minute, discharging then 51,700 cubic feet of air per minute. The current of air from the mine passes to the ventilator along an inclined drift leading off from the upcast shaft at a little depth below the top; and the top of the upcast shaft is closed by a moveable cover, which is lifted by the ascending cage on arriving at the top, the weight of the cover counterbalanced by weights. This is the first mechanical ventilator that has been applied in the working of the South Staffordshire Thick or Ten-yard coal; and it has now been running about nine months, without a single stoppage for repairs of any description, and is doing excellent work, the total cost of the fan, with engine and connections, being only about one-third of that of an ordinary ventilating furnace for producing the same amount of ventilation. A comparison of actual working between the furnace and the fan at a colliery in the North of England shows that with a consumption of only two-thirds as much coal the fan supplies nearly double the amount of air obtained with the ventilating furnace. Several of these ventilators are now at work at collieries in different parts of the country, some of which are as large as 30 ft. diameter and 10 ft. in width, capable of delivering 100,000 cubic feet of air per minute; and they are so free from liability to get out of order that no accidents of any consequence to the ventilation have occurred with any of them.

THE INSTITUTION OF CIVIL ENGINEERS.—At the meeting of this Institution, on Tuesday (Mr. Thomas Hawksley, Vice-President, in the chair), the following candidates were declared to be duly elected, including nine *Members*—Mr. Valentine Græme Bell, late resident engineer, Mont Cenis Railway; Mr. Valentine Browne, engineer-in-chief of the Northern District of the Great Southern and Western Railway of Ireland; Mr. Benjamin Shaw Brundell, Doncaster; Mr. James Buchanan Eads, engineer of the St. Louis Bridge Company St. Louis, Missouri, U.S.A.; Mr. Charles Caulfeild Fishe, resident engineer of the East and West Junction Railway; Mr. George Fisher, resident engineer of the Taff Vale and other railways, Cardiff; Mr. Ferdinand Wilhelm Weghorst Lüders, chief engineer of the Copenhagen Harbour Improvements; Mr. Richard Moreland, jun., Old-street, St. Luke's; and Mr. Bernhard Samuelson, M.P., Banbury. Eleven gentlemen were elected *Associates*—Mr. James Clark Bunten,

Anderston Foundry Company, Glasgow; Mr. John Collinson, chief engineer of the West Wisconsin Railway, U.S.A.; Mr. Edward Gershom Davenport, Westminster; Mr. Albert Chesterfield Jenour, assistant engineer, Harbour and Breakwater Works, Table Bay, Cape of Good Hope; Mr. Henry de la Poire Murphy, nautical assistant to the executive engineer, Bombay Defences; Mr. John Noble, assistant general manager of the Midland Railway; Mr. Frank Bailey Passmore, locomotive department, Mont Cenis Railway; Mr. Thomas Cheveley Rayner, Sible Hedingham, Essex; Mr. Alfred Terry, Chesterfield; Mr. Alfred Authorn Wickenden, late locomotive superintendent of the Great Indian Peninsula Railway; and Mr. John Steddy Winbolt, M.A., assistant surveyor, Straits Settlements, Malacca.—It was announced that the Council, acting under the provisions of section IV. of the bye-laws, had recently admitted Messrs. Andrew Sherwill Busk, James Doull, and Charles Preston Gibbons, as *Students* of the Institution.

SOCIETY OF ENGINEERS.—At the meeting, on Monday (Mr. F. W. Bryant, President, in the chair), a paper was read, "On the Systems and Apparatus Employed for Illumination by Coal Gas," by Mr. William Sugg. The following candidates were duly elected as *Members*—Messrs. William Walker, Metropolitan Board or Works, Spring-gardens; and John Thomas Lloyd, Rye-lane, Peckham. As *Associates*—Messrs. Philip Gray, 7, Cork-street, Burlington-gardens; and Frederick Seebohm-Ultzen, 31, Mark-lane, E.C. The ordinary meetings of the society were adjourned until Monday, Oct. 4.

THE METALLURGY OF COPPER.

The considerable increase which has taken place during the past few years in the production of copper ores, and the absence of a corresponding increase in the demand for the metal, renders it more than ever necessary that the utmost attention should be given to the perfecting of the processes by which the extraction of the metal is effected, in order to compensate for the lower price obtainable by diminished cost of manufacture. In referring to Messrs. Crookes and Rohrig's excellent translation of Kerl's Metallurgy,* in the Journal of April 24, it was stated that the first portion of the volume was devoted to the consideration of the metallurgy of copper, and it is now proposed to give an outline of its contents. The ores containing this metal are found in different geological formations, chiefly in crystalline slates, and in more modern rocks up to the new red sandstone; in rare cases in still more recent formations, as, for instance, in Hungary, where copper ores occur in the triassic formation, or on Lake Superior, where native copper is found in the alluvium. They are found in veins, in beds, and as impregnations associated with quartz, heavy spar, fluor-spar, chlorite, amphibole, pyroxene, &c. Frequently they occur in admixture with other ores, chiefly with lead, zinc, and silver ores; also with iron pyrites, cobalt, nickel, and tin ores. The copper slates of Mansfeld form an interesting cupreous formation, in a geological point of view. The several kinds of ores having been alluded to, as well as their mode of occurrence in the mine, a careful synopsis of processes for the extraction of copper from its ores is given.

The extraction is mostly effected in the dry way, either by a smelting process in a cupola-furnace (the German process), or by treating the ores in reverberatory-furnaces (the English process). The wet way is employed when the ores are too poor for profitable smelting. The process in reverberatory-furnaces consumes much fuel (from 16 to 18 parts of coal to 1 part of copper), and can, therefore, be applied only where good and cheap coal is attainable. Cupola furnaces require good and cheap charcoal and coke, but they concentrate the heat better, and thus economise the fuel. The wet way is applicable when fuel is too expensive, as in Rio Tinto and Huelva, in Southern Spain. The English process does not invariably give good results, for instance, in France, at Boston, and elsewhere, owing to the very great consumption of fuel, which is at least three times as large as in the German process. The advantages afforded by the process in England are founded less on a cheaper production than on the greater ability and facility of buying ores and selling the produced copper which the English copper smelters possess. Rich and pure ores may be worked in either smelting apparatus with equal facility. The cupola furnace is preferable for treating poorer ores, as it permits of a more complete extraction of the copper, and is also preferable for the treatment of very rich pure ores, as it effects a quicker extraction; the richer the ores are the less fuel is used in proportion to the copper produced. The reverberatory-furnace is preferable if the ores are of variable composition, embracing sulphides and oxides, with different gangues and impurities, as the intelligent smelter is able to regulate the more open process if variations in the quality of the ore require it. If the ores are of a constant quality they allow of a regular and continuous process in cupola furnaces. Reverberatory-furnaces are preferable for larger, and cupola-furnaces for smaller productions. The process in reverberatory-furnaces, therefore, is chiefly adapted to sufficiently cheap ores, varying in quality, containing a medium amount of copper, and when coals are very cheap, the building materials for the furnace are refractory, and a large production is intended; smelting copper ores in reverberatory-furnaces requires less skill than smelting lead ores.

Sulphuretted ores and products may be treated in cupola-furnaces, in reverberatory-furnaces, or by the use of both. Where the cupola furnace is used the ores and products are repeatedly roasted in heaps or mounds, and afterwards submitted to a reducing and purifying smelting in cupola-furnaces for the production of black copper. Coal is the chief reducing agent. The resulting black copper is refined in small hearths or in blast reverberatory-furnaces. If the ores are free from silver and gold they are smelted either in sump-furnaces, as in Atvidaberg, Fahlun, Röraas, Szaska, and Agordo, or in cupola-furnaces, with two open eyes, which are adopted in Sternerhütte, Dillenburg, Upper Harz, Kupferberg, and Riechelsdorf; in India and Japan these ores are smelted in crucible furnaces. If silver and gold are contained in the ores they are extracted either direct from the ores and the matt, as at Nagybanya, Fahlun, and Müsen, or from the matt only, as in Oeblarn; or this extraction is effected from the black copper; the latter method is adopted in the Harz and at Sziklowa. When reverberatory-furnaces are used the ores and matt are roasted either in mounds or in reverberatory-furnaces, and smelted in the reverberatory-furnace for the production of black copper, the sulphur serving in the latter process to reduce the oxides formed in the roasting process; the black copper is then refined in air reverberatory-furnaces. The ores treated are mostly free from gold and silver. This process is used in South Wales, Dillenburg, Elbkupferwerk, Duisburg, Freiberg, Bendorf, and Kaafjord. At Mansfeld the copper slate is smelted in cupola-furnaces, the resulting matts are concentrated in cupola and reverberatory-furnaces, the black copper is smelted in cupola-furnaces, then the first refining is effected in small hearths, and the final refining in reverberatory-furnaces. Modifications of the combined process are employed in other districts. Oxidised ores and products are treated either in cupola-furnaces, as in Chessy and Perm, or in reverberatory-furnaces. Native copper is smelted at Grünthal in cupola-furnaces, and in some other cases in reverberatory-furnaces.

Reduction in the wet way embraces the decomposition of cupreous solutions by iron, as in Anglesea, Schmöllnitz, Rammelsberg, Wicklow, Maidenpek, and Rio Tinto. Oxidised ores are treated by decomposing a solution of chloride of copper by means of iron. This may be effected, as at Alderley Edge, Linz, and Stadtbergen, by dissolving the substance in liquid muriatic acid, or by treating it with a liquid containing chloride of iron; or, lastly, by heating the ores with concentrated muriatic acid, chloride of iron, or chloride of magnesium. Another process consists in decomposing a solution of sulphate of copper by means of iron. For this purpose the ore is treated either with sulphuric acid, or with a solution of sulphate of iron. Sometimes the copper is obtained by decomposing an ammoniacal solution containing it, and sometimes by decomposing a solution of sulphite or hyposulphite of copper by means of sulphide of sodium. Sulphuretted ores are treated either by decomposing a solution of chloride of copper by iron, sulphide of calcium, or lime; or by decomposing a solution of sulphate of copper by iron or sulphuretted hydrogen. In the former process the roasted ores are treated either with liquid muriatic acid at the common temperature (seldom at the roasting temperature), or with muriatic acid in the form of gas. In some cases raw pyrites is roasted with common salt, or the pyrites is first subjected to an oxidising roasting, and afterwards chlorinated. At Schmöllnitz and Rio Tinto, where the latter process is adopted, the disintegrated pyrites is lixiviated with water to obtain a solution of sulphate of copper. At other places the ores are roasted in heaps, or in cupola or reverberatory furnaces, and afterwards lixiviated with water. According to Dähne's method, the roasted ores are heated with sulphate of iron, and then lixiviated. Levis and Robert treat the roasted ores, or matt, with liquid sulphuric acid; this has also been used in the form of gas. Black copper is treated by dilute sulphuric acid in the presence of atmospheric air.

The general character of the several processes having thus been pointed out, the various details connected with them are carefully and elaborately given, and, in connection with the calcining and roasting processes wherein the principal evolution of the noxious copper smoke takes place, it is observed that of late years great attention has been paid to the roasting of copper ores, as this operation is the chief cause of the formation of injurious fumes, commonly called copper smoke, emitted by copper works. The parts of the smoke which are chiefly injurious to animal and vegetable life consist, according to analysis, principally of sulphurious acid, and only to a very small degree of sulphuric acid. By the experiments of Mr. Turner it has been ascertained that an amount of sulphurous acid, even as small as 1-10,000th part of the atmosphere, proves fatal to vegetable life. Now, copper smoke is charged with about 1-10th of this substance, and the neighbourhood of copper works in this country, chiefly in South Wales and Lancashire, show the highly injurious effects which it produces. In the volume now under consideration careful accounts are given as to what has been done to abate the nuisance, and as an opportunity is thus afforded for ascertaining the merits and defects of each process which has been employed, copper smelters and others will be greatly asssisted in any future efforts, either to prevent or utilise the smoke. The information as to the various processes connected with the smelting of copper having been thoroughly exhausted in the former portion of the chapter, the treatment of copper ores by the wet way is explained in an equally elaborate manner, the subject being judiciously divided into the transformation of the copper into a soluble state, the lixiviation of the copper salts, purification of the lixiviums before precipitating from iron, precipitation of the copper, and treatment of the products of precipitation respectively. So complete a treatise on the metallugy of copper as that contained in Messrs. Crookes and Rohrig's works has not hitherto been attainable to the English student in metallurgy, and as it is probable that less is known of the metallurgy of copper than of that of most other metals in ordinary everyday use, the work will really prove a valuable acquisition to those interested, turning the ores of copper, wherever they may be found and whatever may be their quality, to the greatest commercial advantage. It will prove alike useful to the practical mine agent and to the smelter.

* "A Practical Treatise on Metallurgy." Adapted from the last German edition of Prof. Kerl's Metallurgy. By WILLIAM CROOKES, F.R.S., and ERNST ROHRIG, Ph.D. In three volumes. Vol. II.: Copper, Iron. London: Longmans, Green, and Co.

LITERARY NOTICE.

Nature-Study, as applicable to Poetry and Eloquence. By HENRY DIRCKS, C.E., LL.D. London: Moxon. 1869.

We are induced to give a lengthened notics of this work rather in connection with the fact of the author being a civil engineer than from finding in it anything bearing on scientific or ordinary practical results. It must not be overlooked that while some men never get out of the single groove in which their education and profession placed them, there are not wanting in science and literature minds of a many-sided character, capable of succeeding in a variety of pursuits. Thus Watts, the optician, flourished as an engineer, and would often, in the privacy of the family circle, give long extemporary romantic narratives, the result of his fruitful and ingenious imagination. Goethe, the great German poet, dramatist, and art-critic, wrote an elaborate scientific work on colours. Sir Humphry Davy takes rank both in science and literature; and the late Mr. Crosse, the distinguished electrician, has left us specimens of his poetry. Need we, then, be surprised to find that Mr. Dircks should have lightened the labours of a professional life by the devotion of a sufficient space of his leisure hours in tracing from their own works how, and in what particular way, poets have studied Nature, although such study may have been undefined in their own minds? The art of painting was long known before perspective was ever thought of, and yet in the rudest of early paintings some clumsy attempt at perspective is traceable. Mr. Dircks does not pretend to be a poet, or to deliver rules for poetical composition; but he lays down very clearly and satisfactorily the best and most simple manner of generalising subjects in Nature, and of analysing them in such a way as shall bring to light much valuable material for the poet's use. The poet can only write about what he sees and feels, but we daily see objects before us in Nature with different degrees of observation. It is the province of the poet to see further into Nature than the ordinary mass of mankind; but it is manifest that his observation, however acute from natural sensibility to beauty, is not entirely independent of culture. And yet poets have for centuries been, more or less, students of Nature, by the simple aid of faculties implanted in them—from pure unaided sensibility to the wide-spread charms of external Nature. It was impossible that such a process should progress for so long a period without exposing to some active mind the basis or principle actuating the poet's mind in his transferrence of Nature's influences to song. Many persons are born poets, painters, and musicians; they perform wonders in a most artless manner; but will anyone pretend that, though they can trace the rules unknown to the young painter or musician, the poet alone, whether in youth or age, is the only intellectual being who can treat of Nature independent of any system whatever?

In his Preface Mr. Dircks has given a complete general view of the subject, and his elaborate and exhaustive work demonstrates the truth of all he advances. To begin, he traces first simple words, then sentences, and lastly poetical compositions. The first four chapters are highly interesting, from exposing the absolute confusion of ideas that exists among critics of every class. He gives the views of Bowles, Aitkin, Darwin, Wordsworth, Taylor, Arnold, Shairp, Kingsley, Emerson, Moir, Coleridge, Max Muller, De Quincey, and others, to prove his point in this respect; and nothing, certainly, can be more convincing of the caotic confusion existing among the several opinions expressed by men of erudition on this singularly interesting subject. Mr. Dircks conceives that he has discovered the key to unlock the entire mystery of Nature-Study, and, therefore, to throw open to poetical minds untold treasures of precious poetical materials. It is a species of new mining district, rich in veins of all kinds of metals, and stored with gems of untold lustre and value! His fifth chapter commences, and the eleventh closes, examples of descriptive and other kinds of poetry, affording a most pleasing and amusing miscellany of the choisest poetical illustrations we have seen brought together, derived from sacred and profane, ancient and modern, English and foreign poets and prose writers. And it is from these, and not from any preconceived views of his own, that he has deduced and laid down the system proposed for extending our examination into Nature, and thereby adding to, instead of re-using and re-modelling what has grown stale; while Nature is prolific in her stores, and only requires to be properly dealt with to yield abundantly all that the poet most ardently desires.

Mr. Dircks heaps unsparing censure on all human attempts at mysticism; he cannot coincide with Behmen, Dr. More, Swedenbourg, and similar mystics; neither is he at all favourably disposed to the principle laid down by the Rev. Mr. Kingsley, that mysticism is of the first importance to a great poet, and he, therefore, condemns it alike whether in Tennyson or any other writer. Quoting from "In Memoriam," he observes—"Either Homer, Shakspeare, Milton, Burns, and Wordsworth are not poets, or the foregoing is so mystical and contra-natural as not to belong to a high order of poetry; but if it is simply an experimental effort, it certainly exhibits a striking contrast to the results of correct Nature-Study." Mr. Dircks appears to have originated a novel view of Nature in respect to its negative side, and the studying of Nature for aiding satire, irony, ridicule, &c., as exemplified in the tenth chapter, which will be certain to excite much entertainment from its curious and amusing illustrative matter, derived from Shakspeare, Swift, Pope, Butler, and various other sources.

Bearing in mind that Mr. Dircks makes not the slightest claim to the originating of any system of his own, but claims solely to have discovered in the practice of the poets themselves the system on which they all indisputably worked, while examining and applying those resources that are common to all animate and inanimate Nature, the reader who passes over the evidence will be in imminent danger of being dissatisfied with Mr. Dircks' summing up, as too simple and obvious, and devoid of the customary depth, intricacy, and mystery of all previous writers. In the first place, Mr. Dircks views all external Nature—mountain, hill, and dale, the water, and the air—as so much lifeless and incommunicable matter. He refuses all belief in their "breathings," "voices," and "spiritual influences." All these he gives to mind itself, acting on dead matter, and throwing life, as it were, into the very ruins of Rome, or Pompeii, or Herculaneum. But it has been a fashion with some poets to pervert this law of Nature, and talk of their absolute and direct communings with this dead matter—these rocks, stones, and bones. Of course, men so imbued will take an invcterate dislike to anything too common-sense to be within the scope of human capacity to grapple with. The material universe is sketched by Mr. Dircks in a way purposely to avoid all affectation of scientific influence, showing that the ancient system of four elements will answer every purpose; he, therefore, places at the head of his programme fire, water, earth, and air, and on these he generalises as far as each will admit, or as the writer may choose to appoint. Each matter, under each head, may be further examined, so that while the first process was a generalisation we now arrive at a particularisation, or analysis, which may be carried to an indefinite extent. It is not proposed to write these matters in an essay form, but tabulated, or after the style of a programme, or syllabus. These it is recommended to collect in a commonplace book for future use; or at once to illustrate with verses, as the point arrived at may suggest. It appears that Moir was of opinion that science was fast sweeping away the resources of poetry, an opinion which has been combatted by Humboldt, and has the hearty support of Mr. Dircks, who shows that the study of Nature, as pursued by the poet, is the very antipodes of that which occupies the philosopher. Let anyone attempt to deduce scientific facts from poetry; let us suppose the subject to be water, and what do we learn from the poetry of all lands? That it is impressible without retaining that impression, that it takes the form of the vase in which it is placed, that it is unfit for writing or painting, that drops of it are as gems, pearls, &c., that a pebble thrown into it causes circles on its surface, that the swan swims on it double (swan and shadow), that it inverts the landscape, and snow melts in it, &c. We have here the very germ of the principle traced by Mr. Dircks as running throughout all poetical compositions touching on Nature in any of its creatures, objects, or phenomena, and which forms the groundwork of the system he has so ably and ingeniously laid down, and which we think must eventually lead to a complete reformation in Nature-Study. No doubt the Philistines will be upon him ere long, for it is hardly to be expected to be otherwise than that such a work, emanating from such a source, will have to contend with much hostility; and we can see in its very originality and simplicity that which is most likely to mislead the over-hasty, inconsiderate, and petulent. Mr. Dircks' is a critical work, yet not so as regards the various classes and the composition of poetry, but solely in the matter of how Nature has been studied hitherto by poets, as evidenced in their own productions; and ascertaining the method of that study, to amplify and extend it by rule, without waiting for happy accidents, or the so-called, though doubtful, interposition of inspiration. We repeat, that a careful perusal of Mr. Dircks' opening essay, or preface, lays bare the whole case in a most lucid and satisfactory manner; and we feel assured that following chapter by chapter, step by step, throughout his well-arranged evidence, no one can help admitting the reasonableness of the system as he has traced it. Yet there may be those who will declare it to be too methodical for the frenzied poet, and only suitable for poetasters. On our part, however, we simply take the facts before us, the evidence adduced, and the ruling of the critic on such evidence, which to our mind is perfectly conclusive.

The work is dedicated by permission to the Right Hon. Lord Houghton, and is an extremely handsome octavo volume, exceeding 400 pages; and as a first attempt to unravel a very important and interesting subject, we esteem it to be well deserving of public patronage.

Meetings of Mining Companies.

GENERAL MINING ASSOCIATION.

An extraordinary general meeting of shareholders was held at the offices, Old Broad-street, on Tuesday,—Mr. H. BOGGS in the chair.

Mr. J. B. FOORD (secretary) read the notice convening the meeting.

The report of the directors stated that they regretted the result of the year's operations had not proved more favourable, although it cannot have been altogether unexpected. The demand for the coal during the last three years has been comparatively upon a limited scale, whilst the continued but unavoidable outlay towards completing the new works at the Albion and Sydney Mines has amounted within the last four years to upwards of 66,000*l.* (23,000*l.* having been expended in the last year alone). To these two causes, therefore, may be attributed the unsatisfactory result which the accounts exhibit. It will, however, be gratifying to the proprietors to learn that, with the exception of fixing the pumping and winding-engines at the Sydney Mines, the works are completed, and the expenditure nearly at an end. Henceforward the three establishments of the association in Nova Scotia may be considered indisputably the most efficient in the dominion of Canada. The quality of the coal from the new pits which have recently been opened at the Albion Mines has been proved on trial to be most superior for gas purposes. It is to be regretted that in consequence of the custom which has prevailed for the last twenty-three years of dividing nearly the whole amount of the profits realised among the proprietors (the sum paid in dividends having amounted to 651,009*l.*, and the amount of capital laid out in improvements to 89,456*l.*) no fund has been set apart to meet the cost of renewing or extending the works. By the terms of the Deed of Settlement of the association the power of raising funds is confined exclusively to the issuing of new shares as capital, to which mode the directors resorted in 1867, by creating 2500 new shares, thereby realising 44,439*l.*, which sum has been applied to the purposes then intended. With this addition they have hitherto met the demands made upon them by keeping an account current with the bankers, at the colonial rate of interest (7 per cent.) during the winter months. This system, however, is found to work disadvantageously, and the directors have come to the conclusion to appeal to the proprietors for power to raise an additional capital to the extent of 50,000*l.*, and thereby to relieve the association of the disadvantages above alluded to. The directors, therefore, feel justified in proposing a course which they are advised can be safely followed, in altering the Deed of Settlement of the association, and obtaining powers to raise money by loan, suggesting at the same time that a certain amount of the profits should be laid aside previous to the declaration of every dividend for the purpose of paying off any loan which may be contracted. The alteration in the Deed of Settlement can be effected under an express provision (contained in the Deed itself) by the vote of the proprietors, giving their sanction to resolutions already passed by the directors at an extraordinary meeting. Should the proposals receive the sanction of the proprietors, the directors will proceed to borrow not exceeding 50,000*l.*, in such sums and on such securities as they may find most convenient; probably by the issue of debenture bonds for limited periods, and with coupons attached to them representing the half-yearly interest, at a rate below that which has been ordinarily paid for accommodation in the colony. The shipments and sales of coal at all the collieries of the association during the past year amount to 229,397 tons; but the loss incurred—after writing off every item of outlay for sinking shafts at the Forster and Foord Pits, dredging operations, and other charges which come under the general denomination of "dead work"—amounts to 6477*l.* 12s. 11d.; and as the expenditure for dead work is a direct charge upon the coal, it follows that had it not been absolutely necessary to incur this expenditure there would have been a small profit on the working of the year. The completion of the intercolonial railway now progressing in the province will bring railway accomodation within the distance of three miles from the valuable mineral property, hitherto unworked, of the association at Spring Hill, in the district of Cumberland, where coal exists of unexceptionable quality and abundant quantity. The directors are glad to report that there is a prospect of opening a direct trade by the Pictou Railway, between the Albion Mines and Halifax; those mines would thus acquire an outlet for coal during the winter season, the distance between the mines and railway being inconsiderable.

The CHAIRMAN observed that, as this was the first general meeting since his appointment to the office, he wished to assure them that, although an inefficient substitute for their late Chairman, he hoped to make himself useful. He had been an agent at the mines for many years, and was intimately acquainted with every detail connected with the property. They had to regret the loss both of Mr. Bridge and of Sir E. Cunard, their agent in New York, both of whom had been very valuable members of the association. The report went so fully into the affairs of the association that it left him little to say, except that he hoped they would see the necessity of raising the capital asked for, to do which it would be necessary to pass the resolutions which had been prepared by their solicitor. He would be happy to answer any questions as to the report and accounts, the adoption of which he then moved.

Mr. J. C. RUDING considered that the accounts sent to them after the last meeting were in such form as not to be of much service to them. Since then they had another year's accounts, and the directors spoke of raising 50,000*l.* In 1867 they were told that the 50,000*l.* then raised was only wanted to pay off what was due to their bankers and provide working capital. It now appeared that some of that money had been expended upon new works. They were not told that a large expenditure was going on for new works, yet they now found that while their stock of coal was so large they were expending 20,000*l.* in a year on new shafts, which he thought was very inconsistent. He complained of the cost of management both in Nova Scotia and in England, which he observed amounted to nearly 2 per cent. upon the capital of the company. He concluded by proposing that a committee be appointed to investigate their affairs before the resolutions to authorise the directors to raise another 50,000*l.* were passed.

Mr. F. C. WORSLEY so completely concurred with the remarks of Mr. Ruding that he had little to add. He thought he had even understated the cost of management, and that the best thing they could do was to sell up the property and realise at once. He thought if they once began to raise money on the real property of the company, they had better sell at once.

The Rev. G. B. MOORE would go further than either of the preceding speakers, and charge the directors with having raised 50,000*l.* for a special purpose, and not applied it thereto, and with inducing them to take shares by false pretences. These were strong charges, but from the directors' own statements he was prepared to prove both. It was only in the report of April 20, 1869, that the directors regretted the absence of a reserve fund, observing that in consequence of the custom which had prevailed for the last 23 years of dividing all profits, there was no reserve fund, but be maintained that it was the directors who were responsible if they had divided more than should have been divided. He could not see why the banker's debt was not paid off out of the 50,000*l.* raised in 1867.

The CHAIRMAN said that it had been applied to pay off that debt, and the balance had been expended in new works.

Lieut-Col. WESTERN had been for some time a shareholder. He thought the chief error the directors had committed was in saying in 1867 that only 50,000*l.* was required. He would say that he then understood that the money was wanted to pay off the banker's debt and to sink shafts, and the only question was whether it had been so applied. He understood that it had, and that more money was now wanted. He thoroughly believed that the value of the concern was as great as ever, and that there is an immense future before it. He read in the Grand Trunk report that they spent 130,000*l.* per annum in coal, and their line was coming closer to the mines of the association. At present it was a market for much of their coal, and what would it be when extended 400 miles further? Not only would there be a demand for the coal they used themselves, but it would sell at every station along the line. He had no hesitation in concluding that the directors had proposed that which was best for the interest of the shareholders, for they must remember that the directors held more than half the capital of the company, and they did not find the holders of half the capital of a company play tricks. He would like to hear Mr. Brown's observations on the subject.

The CHAIRMAN thought that as the meeting had heard one side of the question it might be worth while to hear something of the other. The old shafts were approaching being worked out, and but for the new works their supply of coal would have been stopped, and of course their business could not have been carried on.

Col. BIGGE read an extract from a pamphlet he published in 1848 or 1849, suggesting the necessity of a reserve fund, and said that if only 9d. per share had been deducted from each dividend, such a fund would have been created. Instead of that they had divided the whole of their profits, and that had brought them into their present state. He moved that a committee of shareholders be appointed to enquire into the report and accounts, and to report as to the necessity of raising the 50,000*l.*——Mr. RUDING seconded the motion.

Lieut.-Col. WESTERN did not think such a step would be quite fair to the directors, and thought, moreover, that in all cases committees of investigation did more harm than good to the companies appointing them.

The CHAIRMAN said that, as to Mr. Ruding's observations, he could only say that he did not think the cost of management excessive, but he might say that with regard to the largest item (which Mr. Ruding had included to bring up the amount to the 2 per cent.) it consisted of a fixed percentage, payable for agency, upon coals sold and paid for. The agent in the United States did not guarantee the debts, but he had made no bad debts of consequence, and during the last five years he had not lost a shilling. It was obvious that the more the association paid him for commission the better it was for them. As to the bad debt of 1784*l.* which Mr. Ruding referred to, it was created some years ago. They took over a life assurance as a security, and the man lived too long, so that the extra amount paid had to be charged. As to the money subscribed in 1867, it had no doubt been properly applied. They had no idea of the amount that would be required out of that raised. If the shafts had not been sunk they would have lost

all their property, but if they could have sold their coal the expenditure would have been paid out of revenue. During the past three years 61,180*l.* had been expended, which was more than the amount now asked for. The expenditure on these works was now nearly completed.

Mr. RUDING remarked that they proposed to raise 50,000*l.*, yet said that the expenditure for new works had nearly ceased.

Mr. BROWN explained that before the abrogation of the reciprocity treaty their sale was 350,000 tons per annum, whilst now it was 200,000 tons, being a diminution of 150,000 tons, upon which quantity alone the profits would have been equal to the extra cost of dead work. No one in the room not absolutely familiar with the property had any conception of its value. They had 52 square miles of coal lands, the best in the country—there is no coal in America equal to the Sydney coal, and at Halifax the Sydney coal always fetches $1 per chaldron more than any other quality. He had drawn out a rough estimate of the contents of their seams, and found that they could raise at least 526,000,000 tons of coal, or an amount more than equal to five time the present annual production of the whole of the mines in Great Britain. This quantity at only 1 cent, or half-penny, per ton would be equal to 1,000,000*l.* But the Government valuation of it was 10 cents. for royalty, which would give 10,000,000*l.* They must understand, however, that the property would not be valuable unless they expended money upon it. He thought about 7000*l.* would complete the new works, of which about 3000*l.* would be expended during the present year. As to the real estate, they had 25,371 acres, the cost of which to the company was 18,800*l.* sterling, or less than 1*l.* per acre, and he estimated the present value of that land at 49,000*l.* sterling, or nearly 2*l.* per acre—some had been sold as high as 8*l.*

A PROPRIETOR considered it curious that they should sell their property when it was declared to be so valuable.—Mr. BROWN explained that no mineral land had been sold. At the time the property was acquired some land, worthless for mining purposes, was included in the purchase, and it was some of this that had been sold.

Mr. J. BRIDGE said that nothing could be better than what they had heard concerning the value and prospects of the property, but it did not prove whether they ought to raise the money in the manner proposed—by borrowing. He thought they ought not to saddle themselves with a permanent debt if it could be avoided. It appeared that the money was required to pay off a debt now owing to the bankers. They had borrowed money from the bankers, and he conceived that exactly as the bank had been willing to lend the money so it would be willing to continue the loan. The company was now making profit, and if they got money on debentures they could not readily relieve themselves of the debt by paying it. The only way the property will be thoroughly safe would be to (say) pay off the banker's debt out of the profits. He would say if it were necessary to raise the money for working the mine let it be raised, but if it were merely for additional convenience let the amount be paid out of future profits.

Mr. H. WARRE explained that it was objectionable that the association should be in the position that whilst the bank could draw upon them at any time, the directors had no power to raise the funds necessary to meet the claim except upon their security as individuals. The position of their transactions with their bankers was this. At the end of each shipping season their account with their bankers about balanced, and they then commenced to overdraw to work the mines whilst there was no shipping, the consequence was that by the time the next shipping season commenced they were about 30,000*l.* in debt, which debt was paid off by the close of the season, when they again commenced to borrow. Although some strong expressions had been used he hoped they (the directors) had not entirely lost the confidence of the proprietors, and that they would see the advisability of empowering them to raise an amount which would put them beyond the control of their bankers, by rendering them independent of their aid.

Mr. J. E. BRIDGE (a director) could not be surprised that the proprietors were dissatisfied because they had no dividend, but he could assure them that the directors had done their duty as faithfully as ever. They had committed one fault he admitted, but it was that they had given the proprietors too much; the feeling at the board, however, was that as the calls had been all paid by the original proprietors for many years without receiving any dividend, it was felt that when the profits commenced they should be divided. It should be remembered that they had paid 650,000*l.* and over in dividends, and out of profit they had also expended 89,456*l.* on improving the works.

The CHAIRMAN remarked that they owed the money, and it must be paid; the question, therefore, was the most convenient way of raising it.

Mr. BIRCHAM (Messrs. Bircham, Dalrymple, and Drake) had been called in as solicitor of the company to advise the directors upon the question of raising the 50,000*l.* He found that under the company's deed, which was drawn in the old times of unlimited liability, there was an imperative provision against the power to borrow, because the power to borrow ceased a short time after the company started. The directors had no power to pledge the liability of the individual proprietors. It appeared to him that it was a question for the proprietors whether they would forego dividends for the next five years, or give the directors power to borrow. His advice was to arm them with the power to borrow, limiting the amount to be borrowed. The resolutions which he had framed to carry out this object were in the largest possible terms, as he conceived that to be the best course; he thought it better to pass resolutions with only two limitations—firstly, as to the amount; and, secondly, with the understanding that the individual liability should not be pledged.

Col. BIGGE thought the committee of enquiry should consider whether it was necessary to raise the money at all, and if so, the best means of doing so; should enquire generally into the management of the Association, and ascertain whether the deed cannot be modernised.

Mr. R. PALGRAVE, auditor, urged the necessity of the money being provided at once, in order to ensure the company against possible difficulty.

Mr. BIRCHAM then read the formal resolutions, and in the course of a lengthened discussion which ensued the directors consented to give their word that in the event of the proprietors appointing a committee of investigation (to which they had not the slightest objection) they would not under the power which the resolutions would give them raise more than 30,000*l.* until the committee had made their investigation and reported; whereupon the report and accounts were put and adopted, and the resolutions prepared by the solicitor were unanimously agreed to.

Mr. BIRCHAM observed that the directors having pledged themselves not to raise more than 30,000*l.* without referring to the committee, that committee had better be appointed by the meeting.

It was proposed and seconded that Col. Bigg, Mr. Ruding, and Mr. Kettle be the committee of investigation; but upon the Chairman putting the motion to the meeting (the directors not voting) only 5 hands were held up for it and 13 against, and no other names being proposed, the subject dropped.

The election of directors and auditors was then proceeded with, Messrs. Henry Warre and W. Digby Seymour being unanimously re-elected directors, and Mr. R. Palgrave auditor. The customary vote of thanks was then passed, and the meeting separated.

[For remainder of Meetings see to-day's Journal.]

FOREIGN MINING AND METALLURGY.

The course of Belgian coal production is now gravely interrupted by strikes, but notwithstanding this stocks are only very slowly exhausted, and it is anticipated that they will still present some importance when the period arrives at which the navigations will be closed. It is stated that renewals of contracts for great industries have only been made slowly this year, while on the other hand the coal owners are not at all disposed to abandon a part of the improvement in prices which they established with considerable difficulty during the winter season. Although the state of affairs is for the moment one of difficulty, the great industries of Belgium—metallurgy, glass making, and sugar production—appear destined to enjoy considerable activity during the next few months; and this must eventually benefit the coal trade. No fresh order of any importance is stated to have reached the Belgian rail mills, but several affairs are stated to be in course of negociation, and it is hoped that they will soon result in something tangible; for the rest, the present state of the Belgian iron trade continues tolerably good. It is not the same with Belgian construction workshops, which find it difficult to continue steady and uninterrupted operations. Notwithstanding this, the following curious story is told of the Belgian works:—A contract for 30 locomotives, to weigh 30 tons each, and to be delivered in seven months—that is to say, at the close of November—was proposed a few days since to three of the most important Belgian construction shops, at 2520*l.* per engine, delivered at St. Petersburg. The representatives of the establishments in question, however, refused the order, on the ground that they must have 120*l.* more per engine, and that three additional months must be allowed for the construction of the engines. What renders the proceeding all the more remarkable is that the Creusot Works (France) recently accepted a contract for locomotives on similar conditions, for the same destination, at 2472*l.* per engine. The Belgian rolling mills, as has been already hinted, have their production engaged for several months to come; the result has been a serious advance in prices. It is also stated that a contract for 30,000 tons of Vignoles rails, with accessories, delivered free at Antwerp, has been refused by several establishments at 6*l.* 16s. per ton, deliveries to be made in the course of 1870. This affair will probably pass, under these circumstances, into English hands. The market for merchants' iron and plates is supplied with a good current of orders, and prices are maintained with considerable firmness.

The concern known as the Société Nouvelle des Forges et Chantiers de la Mediterranée appears to have had a prosperous time of it during 1868. Not only has the company been enabled to form a redemption fund of more than 140,000*l.*, as well as a reserve of more than 200,000*l.*, but the meeting just held was in a position to fix the dividend at 4*l.* per share, as in 1867. A distribution of 1*l.* 4s. per share having been made on account in November, 1868, a further payment of 2*l.* 16s. per share is now taking place. The original capital of the company was only 280,000*l.*, so that surprisingly good results appear to have been attained. The quantity of coal carried over the Western of France Railway increased last year to 547,000 tons, as compared with 523,000 tons in 1867. This result is attributed to the opening of a line from Amiens to Rouen, which enabled 28,000 tons of coal from the North of Belgium to arrive on the network *via* Cleres. The proportion of English coal carried over the network, nevertheless, remained last year at 71 per cent. of the whole coal movement; this proportion was about the same as that noted in 1867. The quantity of gas sold by the Belgian General Company for Lighting and Heating by Gas amounted in the seven months ending March, 1869, inclusive, to 242,497,071 English cubic feet, as compared with 226,879,289 English cubic feet in the corresponding seven months of 1867-8, showing an increase of 15,617,782 English cubic feet in 1868-9.

The advices which come to hand from the principal French metallurgical centres continue satisfactory, and it is hoped that the present state of affairs will be maintained. In the Haute-Marne, a province which had hitherto participated in the smallest degree in the general animation of the markets, mention is now made of numerous orders. Hitherto country iron merchants had not believed in the advance, but on seeing it maintained they have been forced to make purchases, and have been obliged to pay 8*l.* per ton for rolled iron from coke-made pig, which will be carried, it is stated, by some works to 8*l.* 4s. and, perhaps, to 8*l.* 8s. per ton. Iron from coke-made pig is quoted at 9*l.* to 9*l.* 4s. per ton; other articles show no change in quotations. It is understood that the Crassiers furnace, at St. Dizier, has just been let by MM. Leclerc and their consorts, in order to be converted into an establishment for castings, first and second fusion. The next meeting of the Champagne Committee of Forgemasters will be held May 11 at St. Dizier. The Moselle and the Meurthe are now represented as almost overdone with orders for iron; all the contracts offered cannot be excepted, and the present state of the works tends to the expectation of an early advance. The price of refining pig is now well established at 2*l.* 15s. 2d. to 2*l.* 16s. per ton. Out of the three Naix blast-furnaces in the Meuse only one had been in operation for some time past; a second has just been lighted, and it is proposed to shortly bring the third into activity. In the department of the Nord the production of iron shows such activity that the raw material has reached a very high price. The rolling-mills, or rather their proprietors, are abundantly provided with orders, and have only one pre-occupation—that is, their supply of refining pig. It is, then, very natural that 2*l.* 15s. 2d. to 2*l.* 16s. per ton should be the basis price of contracts which are concluded; we shall, probably, see quotations advance still further. No. 2 iron is quoted firmly at 8*l.* per ton in warehouse at the works, with a scale of 8s. per class, with the exception of No. 3, which is dealt in at 9*l.* to 9*l.* 4s. per ton. There are rumours of a Customs union with Belgium being in contemplation.

There has been some little improvement noticeable in copper of late. At Havre, Chilian in bars has made 73*l.*; refined ditto, in ingots, 78*l.*; Peruvian mineral (pure standard), 72*l.* to 74*l.*; United States (Baltimore), 78*l.* to 80*l.*; ditto (Lake Superior), 88*l.* to 90*l.*; Mexican and La Plata in bars, 68*l.*; old yellow copper, 44*l.* to 50*l.* 16s.; red ditto, 66*l.* to 72*l.*; ditto bronze, 66*l.* to 72*l.* per ton. Tin has shown some irregularity in quotations. The Dutch markets, which may be said to regulate the rest, have exhibited a decided fall, quotations having declined from 82½ fls. to 80 fls., while even 79 fls. was accepted recently for some rather considerable lots. Billiton has followed the retrograde movement, and was last quoted at 77¼ fls. to 77½ fls.; as hitherto consumers have only purchased to satisfy their most urgent wants. At Paris, Banca has made 142*l.*; Straits, 138*l.*; and English, 130*l.* Zinc has been offered at lower rates on the German markets without provoking, however, much demand. Lead has been well supported, and prices have been rather firmer, especially upon the German markets. At Paris, Spanish saumons have brought 19*l.* per ton; French ditto, 19*l.* 8s.; English ditto, 19*l.*; and German and Belgian ditto, 19*l.* 8s. per ton.

RHENISH PRUSSIA—PERSEVERANCE REWARDED: ST. JOSEPHSBERG MINE.—In the year 1694 a deep adit was commenced to cut the immense lodes seen in the Vernerberg Mountain at 45 fms. under the immense open cuttings which are reputed to have been worked for copper for many centuries. About the year 1800 this was accomplished, and since that time immense profits have been realised; still the mine is only 50 fms. under adit. About six years since the driving of this adit was recommenced to two very large lodes, known as the Leopold lodes, at the depth of 50 fms. from surface. These two lodes had been worked to the depth of 20 fms. by another company, by means of a shallow adit, and returned very large profits, and could not be worked deep without machinery, except through the St. Josephberg deep adit; and to effect this object the St. Josephberg Company purchased the Leopold Mine. The first of these lodes has been cut into from 10 in. to 1 ft., and is composed of a soft spar, gossan, red and grey oxide, carbonate, phosphate, and black oxide of copper; a good paying lode. Judging from the work done on this lode in the shallow adit, the lode will be from 9 to to 12 ft. wide; and, having 25 fms. of backs on the lode high and dry above adit for an English mile and a quarter, this lode alone will place the St. Josephsberg Mine once again in a prominent position amongst the great German copper mines. This adit has been driven 835 fathoms.

AUSTRALASIAN GOLD.

The value of the Australasian gold imported into the United Kingdom to March 31 was 1,000,420*l.*, as compared with 934,909*l.* in the corresponding period of 1868, and 1,168,150*l.* in the corresponding period of 1867. A large number of Chinese have left the Victorian gold fields; their departure is attributed to the Imperial Chinese Government having caused letters to be written to Australia and California offering great inducements to skilled miners to return to China and work on recently-discovered Chinese gold fields. The quantity of gold received at Sydney by the various escorts amounted in January to 20,412 ozs., of which 12,364 ozs. came from the western districts, 6263 ozs. from the southern districts, and 1885 ozs. from the northern districts. The corresponding receipts in January, 1868, amounted to 22,150 ozs. The quantity of gold obtained in Victoria in 1868 was 1,684,919 ozs., of which 1,087,502 ozs. came from alluvial deposits, and 597,416 ozs. from quartz reefs. Of the 1,684,919 ozs. of gold secured in Victoria last year 1,657,498 ozs. were exported, or 223,810 ozs. more than in 1867. The number of miners at work on the Victorian gold fields at the close of 1868 was 64,658, showing an increase of 1176 during the last quarter of the year. This increase was attributed to the Spring Creek rush. The value of the mining plant in use in the colony at the close of 1868 was estimated at 2,150,432*l.*, and the extent of auriferous ground in working was 884 square miles. The number of auriferous quartz reefs known to exist in Victoria at the close of 1868 was 2651.

The quantity of gold upon which duty was paid in January at the various ports of Queensland was 8550 ozs. The prospects of the Gympie diggings are stated to have improved of late; an increasing quantity of stone was being passed, at the late dates, through the crushing-machines. About 1600 ozs. of gold has been obtained from 31 tons of quartz from the North California reef; this was considered a great success, as a yield of even 2 ozs. to the ton pays very well for crushing. Prospecting parties have been busily engaged in the neighbourhood of Gympie, and reefs of a promising character have been found at Kilkivan, where payable alluvial ground has long been worked. Fresh alluvial ground has also been opened there. At Gooroomjam it is stated that 50 men are at work on payable gold, and a reef is being worked which will yield about 12 ozs. to the ton. The diggings in the neighbourhood of Rockhampton are stated to be turning out well.

Quartz obtained from the Thames (New Zealand) gold fields has yielded of late an average of about 15 oz. to the ton. Prospecting in the neighbourhood of Wangapoa (New Zealand) had resulted at the last date in the collection of 104 oz. of gold, which had been deposited in the bank of New Zealand. About 40 men were at work in January near Wangapoa, although hitherto the existence of gold had not been suspected in the locality. Advices from Southland (New Zealand) report that discoveries of gold-bearing quartz reefs have been made in the western district (Longwood ranges), and on the north-west coast of Stewart's Island; a company had been formed to test the value of the reef in the first-named locality. The total yield of gold in the province of Otago (New Zealand), in 1868, was 143,938 oz., showing a decrease of 3·62 ozs. as compared with 1867. Large sums have been laid out of late in this province in importing powerful machinery and building dredges; on the Molyneux River, more especially between the Teviot and Alexandra, a numerous fleet of dredges has been built, and more are in course of construction.

It has been already stated that the value of the gold mining plant and machinery at work in Victoria was estimated at the close of 1868 at 2,150,432*l.* At the close of 1867, the corresponding total was 2,079,195*l.*; at the close of 1866, 2,068,527*l.*; at the close of 1865, 1,773,271*l.*; 1864, 1,496,609*l.*; and at the close of 1863, 1,503,459*l.*

FOREIGN MINES.

ST. JOHN DEL REY.—Morro Velho, March 29: Morro Velho produce, second division of March, 11 days, 2672 oits.; yield 1·437 oitavas per ton. Gaia produce for the above period, 488 oits.; yield, 1·427 oits. per ton. Remittance received, 21,591 oits.=207½ lbs. troy.

DON PEDRO NORTH DEL REY.—Mr. F. S. Symons (April 1) advises—Produce to date, 25,792 oits.; estimate for month (March), 26,792 oitavas. Remittance, 49,131 oits. (value about 20,880*l.*)—General Operations: The works have been carried on in a satisfactory manner, though the Easter holidays affected the attendance of force. Sinking is progressing, the general body of lode has yielded well, and box work has been taken from the curve. The lode in depth continues to maintain its auriferous quality. In the exploratory works there is nothing new to advise. Force has been increased at Tambor, and during the present year we hope to be enabled to explore this most promising locality more extensively than in last. At deep adit the ground is more troublesome than when last commented on.

ROSSA GRANDE.—Mr. E. Hilcke reports—Remittance, 1203 oits. Our operations at Gongo Mine are going on regularly, and I have nothing of importance to advise from this place. The lode at Mina de Serra is becoming disordered and poor at the eastern extremities of the 30 and 40 fm. levels, and I am sorry to say that our produce will be low this month, partly owing to not being able to resume our works at the 50 east, where we have a good-sized and well-yielding lode. We have suspended operations in the western shaft at the Bahu Mine, and put the force at the eastern exploration.

Capt. Thomas Treloar reports—The Rossa Grande Company has, I think, a magnificent field for exploration, and I feel quite sanguine that at no distant day the company will rank among the greatest companies of the day.

SAO VICENTE.—The report of Capt. T. Treloar, dated March 18, says—The jacotinga formation at the points explored is not, I believe, auriferous. Examining it closely, I find characteristics of auriferous jacotinga wanting.—1. Tens of thousands of tons must in the course of ages have been washed from the side of the mountain down into the valley below, yet, so far as I have examined, no vestiges of washings are to be found.—2. The Canga (or conglomerate of iron ores) which lie above the jacotinga near where it is being explored is wanting in joints commonly found over or near lines of gold.—3. The jacotinga itself is wanting in the usual accompaniments of gold, such as iron glance, mica, talc, and manganese, and in sampling it not a trace of gold can be found. The formation consists chiefly of iron, sand, ferruginous sand, and clay. The cross-cut No. 2 has been carefully and systematically re-sampled, but not a particle of gold was found; thus proving that the gold found in the samples previous to my arrival was imported there in the vessels used for washing, and which vessels had been used for washing gold elsewhere. But though the jacotinga is not auriferous at the points explored, yet it may be otherwise at other places in the company's property. Examining the Capanemma Mountain, at a considerable distance from the present explorations, I find the indications more favourable. There are joints and other indications which are more encouraging; in fact, it would seem as if this deposit of jacotinga had, in ages past, been subject to powerful aqueous agency, and that the present explorations are in the fag end or muddy part of said deposit. We shall, therefore, direct our explorations more towards the centre of the deposit, and for this purpose a cross-cut will be driven and a shaft sunk; but, before they can be commenced, roads will have to be made and huts erected for the workpeople.—Rock Formation: At the eastern section Phillips's shaft has been cleared to bottom, and the horse-whim and tramroad from shaft to stamping-mill repaired. Some stone has been quarried, and the same is now being stamped. This shaft is not on the main lode, but on a branch, called here the Gama lode; it is a mere branch, and not a lode, and already is so much disordered by kilias that I do not think it will continue much deeper. The shaft, however, was not sunk to explore this branch, but to get under some old workings, said to be rich, between this and the main lode, and which may be an off-shoot of the main lode. The sinking of the shaft, therefore, will be directed accordingly. At the western section, near Fawcett's shaft, some little lode is remaining, which it is believed will pay for taking away. But my opinion of this section, as a whole, remains unchanged—it will not pay the company. The superintendent writes that, owing to the Easter holidays, the attendance has been irregular.

ANGLO-BRAZILIAN.—Mr. F. S. Symons (April 1) advises—Remittance, 3892 oits.—General Operations: The Easter holidays have operated against attendance of force. Little alteration has taken place in the features of the lodes—if anything, they are more favourable at Dawson's south and Foster's. At the Gongo Mine the lode is large, and highly impregnated with pyrites, but as yet is not yielding well. The same may be said with regard to the Buraco Secco. But few hands are working at present in each of these sections. On an improvement taking place the force will be increased. Haymen's, Dawson's and Foster's shafts, and the deep adit, are worked day and night. In the latter there is more lode, and it is consequently more favourable for driving.

IMPERIAL SILVER QUARRIES.—L. Chalmers, March 15: There were 16 feet of tunnel made last week. The rock changed very materially for the worse.

— March 21: There were 13 feet made last week, at a cost of $10·23 per foot. We are now in 787 feet, and 490 feet under surface. The rock is not so good as it has been for some weeks, and I anticipate some hard drilling in penetrating the outer crust. No European mail since February 25, my latest dates from London being January 21.

— March 27: I am now beyond 790 feet, but still in the felspathic lava. I am daily expecting to get out of it, and strike either porphyry or the ledge; if porphyry first, then the ledge. I hope it is not dipping east much.

— March 29: Having made 11 feet last week, we are now in 798 feet. The rock has resumed its remarkable appearance and nature, but I am daily expecting to be out of it.

— March 31: During the month we made 57 feet of tunnel, at a cost of $10·21 per foot. You cannot let a contract at anything like this figure. On Sunday we were in 798 feet, and from my calculations should be just under the line of the triumph croppings; but we are still in the felspathic lava. Unable to ascertain the dip of the ledge; and the surface just over the tunnel being covered many feet deep with the debris of the rocks above, I shall not be surprised or alarmed if I have to run 150 to 200 feet more before reaching the ledge. It is now getting anxious work, however, and every day I look for a change. I have, you will see, reduced the expenses here to a minimum, and assuming that we run 13 ft. a week we should reach Florence with from $7200 to $8000. We should then open up a batch of ledges, for the ground there is covered with promising quartz in all directions, and we should have the satisfaction of knowing that we had thoroughly explored the western end of the company's property. I hope this will not be construed into my having any doubt as to the Triumph; I have none. I write at present under great disadvantages, the blockaded mail not having made its appearance.

ALAMILLOS.—April 28: The lode in the 4th level, west of San Rafael shaft is very wide, yielding ¾ ton of ore per fathom. In the 4th level, east of La Magdalena shaft, the lode is small and poor. The ground in the 5th level, east of La Magdalena shaft, is hard for driving, and the lode is split into two parts. The 5th level, west of La Magdalena shaft, is worth 3 tons of ore per fathom; this is opening out a fine piece of tribute ground. We are daily expecting to intersect the lode in the cross-cut in the 5th level, east of Taylor's shaft. In the 6th level, east of Taylor's shaft, the men are put to open on the south side of the level, where we expect an improvement. In the 6th level, west of Taylor's shaft, we hope also to find the best part of the lode on the south side. The lode in the 5th level, west of same shaft, is very wide, and contains an unusual quantity of quartz. The 4th level, west of San Andriano shaft, is worth 1 ton of ore per fathom; the ground is very easy for driving, and the lode has much improved. The lode in the 3d level, west of San Yago shaft, is very large, with good stones of ore, looking better than for some time past. The 2d level, east of Cox's shaft, contains a large lode, yielding ¼ ton of ore per fm. The 2d level, west of Cox's shaft, is also worth ½ ton per fm.; the ground is easy for driving, but the lode is not of much value. The 2d level, east of Judd's shaft, produces also ½ ton of ore per fathom; this end opened some good ground a few days ago, but is very changeable. The 2d level, west of Henty's, is unproductive, and for the present is suspended.—Shafts and Winzes: The men are making good progress in sinking La Magdalena shaft below the 5th level. San Andriano shaft, below the 4th level, is going down in a kindly lode, worth 1 ton of ore per fathom. Pablo's winze, below the 3d level, yields 1 ton of ore per fm. the lode here is not looking so promising as it was. Guirado's winze is holed to the 4th level, and we expect to hole Gandia's winze to the 3d level in a few days. The stopes have not undergone much change this month. We have set on some new bargains, in order to keep up our present rate or raisings, which we estimate at 250 tons for May. The surface works and machinery going on regularly.

FORTUNA.—April 28: Canada Incosa Mine: The 110 fathom level, west of O'Shea's engine-shaft, is worth 1¼ ton of ore per fathom; the lode is large, composed of sulphate of lime and lead ore. The 100, west of Henty's shaft, yields 1 ton of ore per fathom; the lode has improved very much, and we expect to have a long run of ore ground. The 90, west of Judd's shaft, is worth 1¼ ton per fathom; we have suspended this end until we hole Primero's winze. No change has taken place in the 90, east of Addis's shaft, since last report. In the 80, south of Henty's shaft, the ground is still hard, and progress is consequently slow. The lode in the 50, east of San Pedro shaft, is large and regular, yielding 1½ ton of ore per fathom; this end is opening out valuable ore ground. In the 70, east of Carro's shaft, the lode is small and compact, producing 1 ton of ore per fathom. The 80, east of Lownde's shaft, is worth 1 ton of ore per fathom; the lode is very wide; we hope when it gets a little more compact to have an improvement. In the 80, west of Lownde's shaft, the lode is not so regular as it has been, producing good stones of lead occasionally.—Shafts and Winzes: In O'Shea's shaft, below the 110 fm. level, the men are not making such progress as we should wish. We are forcing down Henty's shaft below the 100 with a good party of men, who are making good measurement. Puebra's winze, below the 100, is worth 1 ton of ore per fathom; this winze will be deep enough for the 110 fm. level this month; lode large and open, which speaks well for the 110 fm. level. Primero's winze, below the 80, is worth 1¼ ton of ore per fathom. There being so much water in this winze we have put the men to rise in the back of the 90; when this is holed we shall have good ventilation for the 90 end. Abril's winze, below the 90, produces 1 ton of ore per fathom; this winze is situated about 60 varas to the west of Henty's shaft.—Los Salidos Mine: In the 100 fm. level, west of Morris's engine-shaft, the ground is much harder than it has been. The 90, west of Buenos Amigos shaft, is just the same as when last reported. The 75, west of Buenos Amigos shaft, is worth 2 tons of ore per fathom; the lode is divided into two parts, and lets out water freely. In the 100, east of San Gabriel shaft, we have had a good lode until the last few days, when it entered a strong cross-course, which has cut off the lode. The 90, east of Cox's shaft, produces 3 tons of ore per fathom; the lode is more solid than it has been for the last fortnight. The lode in the 75, east of San Pablo shaft, has again improved, and now yields 2½ tons of ore per fathom.—Shafts and Winzes: Buenos Amigos shaft, sinking below the 90 fathom level, is worth 1½ ton per fathom. The men have got on badly with sinking this month, and have now abandoned their contract; we have now put on another party of men, and hope to get on better in future. The lode in San Carlos shaft, below the 65, is looking very kindly, yielding 1¼ ton of ore per fathom, and the men are getting on well in sinking. The lode in San Pablo shaft, sinking below the 75, is wide and strong, composed of quartz and lead ore, yielding of the latter 3 tons per fathom. Murillo's winze, below the 75, yields 2 tons of ore per fathom and has reached the required depth for the 90 fathom level, and the men are put drive east towards the cross-course. The lode in Colon's winze, below the 90, is small and compact, and produces ¾ ton of ore per fathom. Sagasta's winze, below the 90, is situated east of Prim's winze, and in advance of the 100 end; it is unproductive.

LINARES.—April 28: West of Engine-Shaft: The 110, driving west of San Tomas engine-shaft, contains stones of ore in the upper part of the end, but not enough to attach a value to. In the 85, west of Warne's, some good ore ground was opened in the middle of the month, but it is quite poor at present. The 45, east of San Francisco shaft, is worth 1 ton of ore per fathom; this level, although not so productive as it was, is opening tribute ground. The 31, east of San Francisco shaft, has changed very unfavourably during the past fortnight; it now produces 1 ton of ore per fathom. The 25, east of the above shaft, is passing through a piece of unsettled ground, in which the lode is greatly disarranged.—East of Engine-Shaft: In the 95, east of Taylor's cross-cut, and the 95, east of Taylor's shaft, the lode being unproductive, the driving is suspended.—Shafts and Winzes: San Francisco shaft has reached the 45, and will very shortly be set on towards a 55. The lode in winze No. 165, below the 75, is poor; sinking is temporarily suspended, in consequence of increase of water. No. 166 winze, below the 31, is going down in a kindly lode, worth 1 ton of ore per fathom. No. 167 winze, below the 45, is worth 2 tons of ore per fathom; the lode was much damaged in this sink a few days since, but is again improving, and looks very kindly. There has been no unusual fluctuation in the tribute department this month, and the stopes are yielding very well. The machinery and all other surface works are going on very regularly. We estimate the raisings for May at 325 tons.—Los Quiniento's Mine: In the 45, west of Taylor's engine-shaft, there is still a good lode in the upper part of the end, worth 1 ton of ore per fathom, but in the bottom it is small. The lode in the 45, east of Taylor's shaft, is small, and lets out much water from the north side. The 32, east of Taylor's shaft, has been in old works the greater part of the month. The 32, west of the above shaft, yields ½ ton of ore per fathom; this has opened a good length of splendid lode, but has failed in the past few days. The 32, east of Cox's shaft, is worth ¼ ton per fathom; this end has also fallen off very much in value during the last few days. The 32, west of Cox's shaft, produces 1 ton of ore per fathom; a great length of tribute ground has been driven through in this level, but the lode is not quite so good at present. San Carlos shaft, sinking below the 20, has become unproductive, but we think it will improve again.

[For remainder of Foreign Mines, see this day's Journal.]

LONDON GENERAL OMNIBUS COMPANY.—The traffic receipts for the week ending May 2 was 11,139*l.* 12s. 9d.

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